IMPERIAL INSTITUTE

OF

AGRICULTURAL RESEARCH, PUSA.

TRANSACTIONS

PROCEEDINGS

NEW ZEALAND INSTITUTE,

1872.

VOL. V.

EDITED AND PUBLISHED UNDER THE AUTHORITY OF THE BOARD OF GOVERNORS OF THE INSTITUTE,

BY

JAMES HECTOR, M.D., F.R.S.

Issued May, 1873.

WELLINGTON:
JAMES HUGHES, PRINTER, LAMBTON QUAY.
TRUBNER & CO., 60, PATERNOSTER ROW, LONDON.

PREFACE.

THE Editor has to acknowledge the assistance received from Mr. W. T. L. Travers, Mr. J. T. Thomson, Captain Hutton, Captain Edwin, and Mr. W. Skey, in the revision of the papers by those gentlemen.

He has also to acknowledge the assistance received from Mr. R. B. Gore in the preparation of the Meteorological Tables in the Appendix.

The only change which has been made in the arrangement of the volume since last year is that certain lectures and addresses delivered before the Societies have been printed in the Appendix instead of in the body of the work.

The Illustrations have as hitherto been lithographed by Mr. J. Buchanan, and the Board have again to thank the Honourable Colonial Secretary for allowing the use of the Government lithographic press.

Wellington, 29th April, 1873.

ADDENDA ET ERRATA.

Page 111, lines 8 and 29, for "grapes" read "grasses."
,, 170, ,, 12 for "Macleyius" read "Macleayius."
,, 171, C. 78, for "Himantopus spicatus" read "Himantopus varius."
,, 198, ,, ,, ,, ,, ,,
,, 281, Salticus appressus, line 1, for "·8 inch" read "·4 inch."
,, 282, Salticus minax, line 10, for "libral" read "tibial."
,, 282, ,, line 12, for "four-fifths" read "four-tenths."
,, 283, line 1, for "three-fifths" read "three-tenths."
,, 283, Salticus atratus, line 1, for "male the largest" read "the largest male."
,, 284, line 4, after "specimens" *dele* ";"
,, 284, Salticus fumosus, line 1, for "·8 in." read "·4 in."
,, 285, line 1, for "libral" read "tibial."
,, 285, ,, 24, for "mustilinus" read "mustelinus."
,, 287, ,, 26, for "chelinous" read "chitinous."
,, 311, lines 11 and 12, for "Alexander" read "Anderson."
,, 331, line 25, for "*A. cunninghamii*" read "*A. banksii.*"
,, 340, ,, 7 from bottom ,, ,, ,,
,, 351, ,, 21, before "*Phormium*" insert "*Arthropodium cirrhatum*, Br., *A. candidum*, Raoul."
,, 379, ,, 18, after "gold" *dele* ","
,, ,, ,, ,, ,, "reduce" insert ","
,, ,, ,, ,, ,, "locate" insert "it."
,, 381, ,, 8, for "Secondly" read "Further."
,, ,, ,, 12, for "thirdly" read "secondly."
,, 432, ,, 8 from bottom, for "harbour" read "head."
,, 439, ,, 3, for "marine" read "massive."

CONTENTS.

NEW ZEALAND INSTITUTE.

TRANSACTIONS.

I.—Miscellaneous.

II.—Zoology.

III.—Botany.

PROCEEDINGS.

WELLINGTON PHILOSOPHICAL SOCIETY.

AUCKLAND INSTITUTE.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

OTAGO INSTITUTE.

NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY.

APPENDIX.

ILLUSTRATIONS.

NEW ZEALAND INSTITUTE.

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND INTITULED "THE NEW ZEALAND INSTITUTE ACT, 1867."

BOARD OF GOVERNORS.

(EX OFFICIO.)

His Excellency the Governor. | The Hon. the Colonial Secretary.

His Honour the Superintendent of Wellington.

(NOMINATED.)

Hon. W. B. D. Mantell, F.G.S. (retired 1868), Hon. Col. Haultain (retired 1869), Jas. Edward FitzGerald, C.M.G., (retired 1871), Charles Knight, F.R.C.S., (retired 1872), Sir David Monro, W. T. L. Travers, F.L.S., Alfred Ludlam, James Hector, M.D., F.R.S., Hon. G. M. Waterhouse, Hon. E. W. Stafford.

(ELECTED.)

1872.—His Honour W. Rolleston, B.A., His Honour Mr. Justice Chapman, Hon. W. B. D. Mantell, F.G.S.

1873.—W. Rolleston, B.A., Mr. Justice Chapman, Captain F. W. Hutton, F.G.S.

ABSTRACTS OF RULES AND STATUTES.

GAZETTED IN THE "NEW ZEALAND GAZETTE," MARCH 9, 1868.

SECTION I.

Incorporation of Societies.

1. No Society shall be incorporated with the Institute under the provisions of "The New Zealand Institute Act, 1867," unless such Society shall consist of not less than twenty-five members, subscribing in the aggregate a sum of not less than fifty pounds sterling annually, for the promotion of art, science, or such other branch of knowledge for which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the Chairman for the time being of the Society.

2. Any Society incorporated as aforesaid shall cease to be incorporated with the Institute in case the number of the Members of the said Society shall at any time become less than twenty-five, or the amount of money annually subscribed by such Members shall at any time be less than £50.

3. The bye-laws of every Society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of its annual revenue in or towards the formation

or support of some local public Museum or Library; or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the Museum and Library of the New Zealand Institute.

4. Any Society incorporated as aforesaid which shall in any one year fail to expend the proportion of revenue affixed in manner provided by Rule 3 aforesaid, shall from thenceforth cease to be incorporated with the Institute.

5. All papers read before any Society for the time being incorporated with the Institute, shall be deemed to be communications to the Institute, and may then be published as proceedings or transactions of the Institute, subject to the following regulations of the Board of the Institute regarding publications:

Regulations regarding Publications.

(*a*) The publications of the Institute shall consist of a current abstract of the proceedings of the Societies for the time being incorporated with the Institute, to be intituled, "Proceedings of the New Zealand Institute," and of transactions comprising papers read before the Incorporated Societies (subject, however, to selection as hereinafter mentioned), to be intituled, "Transactions of the New Zealand Institute."

(*b*) The Institute shall have power to reject any papers read before any of the Incorporated Societies.

(*c*) Papers so rejected will be returned to the Society before which they were read.

(*d*) A proportional contribution may be required from each Society towards the cost of publishing the proceedings and transactions of the Institute.

(*e*) Each Incorporated Society will be entitled to receive a proportional number of copies of the proceedings and transactions of the Institute to be, from time to time, fixed by the Board of Governors.

(*f*) Extra copies will be issued to any of the Members of Incorporated Societies at the cost price of publication.

6. All property accumulated by or with funds derived from Incorporated Societies and placed in the charge of the Institute shall be vested in the Institute, and be used and applied at the discretion of the Board of Governors for public advantage, in like manner with any other of the property of the Institute.

7. Subject to "The New Zealand Institute Act, 1867," and to the foregoing rules, all Societies incorporated with the Institute shall be entitled to retain or alter their own form of constitution and the bye-laws for their own management, and shall conduct their own affairs.

8. Upon application signed by the Chairman, and countersigned by the Secretary of any Society, accompanied by the certificate required under Rule No. 1, a certificate of incorporation will be granted under the Seal of the Institute, and will remain in force as long as the foregoing rules of the Institute are complied with by the Society.

Section II.

For the Management of the Property of the Institute.

9. All donations by Societies, Public Departments, or private individuals, to the Museum of the Institute, shall be acknowledged by a printed form of receipt, and shall be duly entered in the books of the Institute provided for that purpose, and shall then be dealt with as the Board of Governors may direct.

10. Deposits of articles for the Museum may be accepted by the Institute, subject to a fortnight's notice of removal to be given either by the owner of the articles or by the Manager of the Institute, and such deposits shall be duly entered in a separate catalogue.

11. Books relating to Natural Science may be deposited in the Library of the Institute, subject to the following conditions:—

(*a*) Such books are not to be withdrawn by the owner under six months' notice, if such notice shall be required by the Board of Governors.

(*b*) Any funds specially expended on binding and preserving such deposited books, at the request of the depositor, shall be charged against the books, and must be refunded to the Institute before their withdrawal, always subject to special arrangements made with the Board of Governors at the time of deposit.

(*c*) No books deposited in the Library of the Institute shall be removed for temporary use except on the written authority or receipt of the owner, and then only for a period not exceeding seven days at any one time.

12. All books in the Library of the Institute shall be duly entered in a catalogue, which shall be accessible to the public.

13. The public shall be admitted to the use of the Museum and Library, subject to bye-laws to be framed by the Board.

Section III.

14. The Laboratory shall, for the time being, be and remain under the exclusive management of the Manager of the Institute.

Section IV.

Of date 23rd September, 1870.

Honorary Members.

Whereas the rules of the Societies incorporated under the New Zealand Institute Act provide for the election of Honorary Members of such Societies; but inasmuch as such Honorary Members would not thereby become Members of the New Zealand Institute, and whereas it is expedient to make provision for the election of Honorary Members of the New Zealand Institute, it is hereby declared—

1st. Each Incorporated Society may, in the month of November next, nominate for election as Honorary Members of the New Zealand Institute three persons, and in the month of November in each succeeding year one person, not residing in the colony.

2nd. The names, descriptions, and addresses of persons so nominated, together with the grounds on which their election as Honorary Members is recommended, shall be forthwith forwarded to the Manager of the New Zealand Institute, and shall by him be submitted to the Governors at the next succeeding meeting.

3rd. From the persons so nominated, the Governors may select in the first year not more than nine; and in each succeeding year not more than three, who shall from thenceforth be Honorary Members of the New Zealand Institute, provided that the total number of Honorary Members shall not exceed thirty.

LIST OF INCORPORATED SOCIETIES.

NAME OF SOCIETY.	DATE OF INCORPORATION.
WELLINGTON PHILOSOPHICAL SOCIETY	June 10th, 1868.
AUCKLAND INSTITUTE	June 10th, 1868.
PHILOSOPHICAL INSTITUTE OF CANTERBURY . .	October 22nd, 1868.
OTAGO INSTITUTE	October 18th, 1869.
NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY	Sept. 23rd, 1870.

WELLINGTON PHILOSOPHICAL SOCIETY.

OFFICE-BEARERS FOR 1872: *President*—J. Hector, M.D., F.R.S.; *Vice-Presidents*—J. C. Crawford, F.G.S., J. Kebbell; *Council*—Captain F. W. Hutton, F.G.S., C. Knight, F.R.C.S., W. T. L. Travers. F.L.S., H. F. Logan, John Buchanan; *Honorary Treasurer*—F. M. Ollivier; *Honorary Secretary*—R. B. Gore.

OFFICE-BEARERS FOR 1873: *President*—Charles Knight, F.R.C.S.; *Vice-Presidents*—J. C. Crawford, F.G.S., Captain F. W. Hutton, F.G.S.; *Council*—W. T. L. Travers, F.L.S., H. F. Logan, James Hector, M.D., F.R.S., John Kebbell, W. S. Hamilton, J. R. George, C. C. Graham; *Hon. Treasurer*—F. M. Ollivier; *Hon. Secretary*—R. B. Gore; *Auditor*—Arthur Baker.

Extracts from the Rules of the Wellington Philosophical Society.

5. Every Member shall contribute annually to the funds of the Society the sum of one guinea.

6. The annual contribution shall be due on the first day of January in each year.

7. The sum of ten pounds may be paid at any time as a composition for life of the ordinary annual payment.

14. The time and place of the general meetings of Members of the Society shall be fixed by the Council, and duly announced by the Secretary.

AUCKLAND INSTITUTE.

OFFICE-BEARERS FOR 1872: *President*—T. Heale; *Council*—Hon. Colonel Haultain, T. Russell, J. M. Clark, Rev. A. G. Purchas, M.R.C.S.E., T. Kirk, F.L.S., T. F. S. Tinne, Rev. J. Kinder, J. Stewart, Assoc. Inst. C.E., His Honour T. B. Gillies, J. L. Campbell, M.D., H. H. Lusk; *Auditor*—C. Tothill; *Secretary and Treasurer*—T. Kirk, F.L.S.

Extracts from the Rules of the Auckland Institute.

4. New Members on election to pay one guinea entrance fee, in addition to the annual subscription of one guinea; the annual subscriptions being payable in advance on the first day of April for the then current year.

5. Members may at any time become Life Members by one payment of ten pounds ten shillings, in lieu of future annual subscriptions.

10. Annual General Meeting of the Society on the third Monday of February in each year. Ordinary Business Meetings are called by the Council from time to time.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Office-bearers for 1872: *Patron*—His Honour the Superintendent; *President*—His Honour Mr. Justice Gresson; *Vice-Presidents*—W. B. Bray, C.E., R. W. Fereday; *Council*—J. F. Armstrong, J. W. S. Coward, J. S. Turnbull, M.D., Julius Haast, Ph.D., F.R.S., G. W. Hall, Ven. Archdeacon Wilson; *Honorary Treasurer*—J. Inglis; *Honorary Secretary*—Llewellyn Powell, M.D.

Office-bearers for 1873.—*President*—H. J. Tancred; *Vice-Presidents*——T. H. Potts, F.L.S., Robert Wilkin; *Council*—Julius Haast, Ph.D., F.R.S., G. W. Hall, Ven. Archdeacon Wilson, His Honour Mr. Justice Gresson, Dr. A. C. Barker, W. Montgomery; *Hon. Treasurer*—J. Inglis; *Hon. Secretary*—C. M. Wakefield.

Extracts from the Rules of the Philosophical Institute of Canterbury.

7. The Ordinary Meetings of the Institute shall be held every first week during the months from March to November inclusive.

25. Members of the Institute shall pay two guineas for the first year of membership, and one guinea annually thereafter, as a subscription to the funds of the Institute.

27. Members may compound for all annual subscriptions of the current and future years by paying ten guineas.

OTAGO-INSTITUTE.

Office-bearers for 1872: *President*—His Honour Mr. Justice Chapman; *Vice-Presidents*—Robert Gillies, T. M. Hocken, M.R.C.S.E.; *Council*—W. N. Blair, C.E., E. B. Cargill, S. Hawthorne, M.A., J. McKerrow, G. S. Sale, M.A., J. T. Thomson, F.R.G.S., P. Thomson; *Honorary Treasurer*—J. S. Webb; *Honorary Secretary*—D. Brent, M.A.

Office-bearers for 1873: *President*—His Honour Mr. Justice Chapman; *Vice-Presidents*—Rev. Dr. Stuart, J. T. Thomson, F.R.G.S.; *Council*—Professor Black, M.A., D.Sc., Professor Shand, M.A., Dr. Deck, T. M. Hocken, M.R.C.S.E., R. Gillies, H. Skey, P. Thomson; *Hon. Treasurer*—J. S. Webb; *Hon. Secretary*—D. Brent, M.A.

Extracts from the Rules of the Otago Institute.

3. From and after the 1st September, 1869, any person desiring to join the Society may be elected by ballot, on being proposed in writing at any meeting of the Society by two Members, on payment of the annual subscription for the year then current.

4. Members may at any time become Life Members by one payment of ten pounds ten shillings, in lieu of future annual subscriptions.

9. An Annual General Meeting of the Members of the Society held on the second Monday of July.

NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY.

OFFICE-BEARERS FOR 1872: *President*—Sir David Monro; *Vice-President*—The Right Rev. the Bishop of Nelson; *Council*—F. W. Irvine, M.D., Robert Lee, The Hon. T. Renwick, Joseph Shephard, George Williams, M.D.; *Honorary Treasurer*—J. Holloway; *Curator and Secretary*—Thomas Mackay.

OFFICE-BEARERS FOR 1873: *President*—Sir David Monro; *Vice-President*—The Bishop of Nelson; *Council*—R. Lee, Hon. J. Renwick, J. Shephard, George Williams, M.D., C. Hunter-Brown; *Hon. Treasurer*—J. G. Holloway; *Hon. Secretary*—T. Mackay.

Extracts from the Rules of the Nelson Association for the Promotion of Science and Industry.

2. The Association shall consist of Members elected by ballot, who have been proposed at a Monthly Meeting of the Society, and elected at the ensuing meeting.

3. Each Member to pay a subscription of not less than one pound per annum, payable half-yearly in advance.

4. Ordinary meetings held on the first Wednesday in each month.

NEW ZEALAND INSTITUTE.

ANNIVERSARY ADDRESS

OF

THE PRESIDENT,

HIS EXCELLENCY SIR GEORGE F. BOWEN, G.C.M.G.

DELIVERED TO THE MEMBERS OF THE NEW ZEALAND INSTITUTE, AT THE ANNIVERSARY MEETING, HELD ON THE 28TH SEPTEMBER, 1872.

GENTLEMEN,—

It is with great satisfaction that in this, as in my previous anniversary addresses, I have to call your attention to the last Report of the Governing Board of the New Zealand Institute. For this Report contains ample proof of the continued prosperity of our Association, and of its practical usefulness in promoting the investigation of the resources of the Colony, and in disseminating the results of the labours of the many independent observers, whose activity has been stimulated by its influence. Moreover, the four volumes of our *Transactions and Proceedings* afford abundant evidence of the beneficial effects of the system of organization adopted under the authority of the Colonial Parliament. The statutes of the Institute insure to each of the affiliated Societies perfect freedom in the management of its own affairs; while, at the same time, they aid and direct the efforts of all by giving support and encouragement in proportion to the amount of work performed.

A glance at the contents of the volumes hitherto published cannot fail to show how important are the additions already made to the knowledge of most of the subjects of inquiry which were suggested in the preface to the first year's *Transactions*; particularly, if we take into consideration the reports contributed by the Geological and Museum departments; which, though not directly controlled, are fostered by the Institute. We find records of original

investigations into the annals and traditions, the mythology and ethnology, of the Maori race; and into the natural resources of this country—in its fisheries, its minerals, and its trees and plants; while the more purely scientific questions connected with its meteorology, its botany, and its zoology, have received a large share of attention.

REVIEW OF VOL. IV. OF THE "TRANSACTIONS" OF THE INSTITUTE.

I will now proceed to review very briefly the last or fourth volume of our *Transactions*.

A considerable portion of this volume treats of what may be termed the pre-historic period of New Zealand. The essay of Mr. J. T. Thomson, on the origin and migration of the Maoris, is an ingenious and suggestive addition to the literature of a subject, the full examination of which should certainly be undertaken without delay, and before the traditional knowledge possessed by the natives is obscured or obliterated by the lapse of time, and by the preponderance of the European settlers. Closely related to this same question is the thoughtful criticism by Mr. Travers of some of the more prominent Maori legends. We have also several instructive papers filled with discussions relative to the Moa. On the one hand, Dr. Haast arrives at the opinion that the extermination of this gigantic bird is of high antiquity, and that it was effected by a people wholly different from, or at least by very remote ancestors of the Maoris of the present day. Dr. Hector, on the other hand, adheres to the view which has hitherto been generally received, viz., that the Moa has become extinct within a comparatively short period before the settlement of these Islands by Europeans, and that it was hunted by the immediate forefathers of the existing aborigines. I would further direct attention to the remarks by Archdeacon Williams and by Mr. Gillies on the foot-prints of the Moa on a sandy deposit on the sea-beach at Poverty Bay; and to the description by Captain Hutton of the moa feathers which have recently been found in alluvial soil in the interior of Otago.

ZOOLOGY.

The contributions in Zoology during the past year have been numerous and varied. The treatment by Captain Hutton of several special branches of this department of science may be recommended as a model for observers. To Captain Hutton we are also indebted for the compilation of the valuable Catalogues of the Birds and Fishes of this country, which have recently been issued from the Museum. Another remarkable paper is a description by Dr. Haast of an extinct gigantic bird of prey (*Harpagornis Moorei*), which he supposes to have far exceeded in dimensions any known bird of the eagle kind, and to have been of proportionate size to the Moa. He believes that,

"as the small Harrier now flies leisurely during the day-time over the plains and downs in search of its food, consisting of carrion, birds, lizards, and insects, so the *Harpagornis* doubtless followed the flocks of Moas, feeding either upon the carcases of the dead birds, or killing the young and disabled ones."* Another gigantic bird, but belonging to a period of much higher antiquity than that in which any Moa remains have hitherto been discovered, is a huge Penguin (*Palæeudyptes antarcticus*), the bones of which were found imbedded in limestone rocks on the West Coast of the Nelson Province. Dr. Hector further contributes a description of the Seals which I was fortunate enough to shoot last year in Milford Sound, while I was there in H.M.S. "Clio." They prove to belong to the species named by Dr. Gray *Arctocephalus cinereus*, and to differ from the Fur Seal of the Falkland Islands (*Otaria nigrescens*), with which they had previously been identified. Mention should also be made of two attractive papers on Natural History by Mr. Travers and Mr. P. Thomson, respectively; and of the excellent observations by Mr. Fereday on the New Zealand Insects.

BOTANY.

The botanical papers in last year's volume are very interesting. The important subject of the distribution of plants in these Islands receives valuable elucidations from Mr. Kirk and Mr. Cheeseman. Mr. Kirk's "Comparison of the Indigenous Floras of the British Islands and New Zealand," showing the different effect of each on the landscape, is peculiarly attractive for the general as well as for the scientific reader. There is also a report, of a most practical kind, on the native and introduced grasses of the Canterbury Province, and their fitness for different purposes of pasturage.

If time permitted, I would gladly advert to several of the contributions on Chemistry, Geology, and a variety of miscellaneous subjects. Indeed, the slight sketch attempted above gives a very inadequate idea of the extent and value of the work performed by the Institute and its affiliated Societies. We must ever rejoice in the intimate connection and general prosperity of these united associations, for (to quote the words of Mr. Travers in a recent address) "each society is but one of a series of grafts upon the tree of scientific knowledge which has been planted in this Colony; and the fruit which each of them bears must be good or indifferent, in proportion to the vigour of the common stock."†

OFFICIAL JOURNEY OF THE GOVERNOR ACROSS THE CENTRE OF THE NORTH ISLAND.

In my anniversary address of last year, after a brief review of the recent *Transactions* and present position of the Institute, I proceeded, in accordance

* *Transactions*, Vol. IV., p. 194.

† *Transactions*, Vol. IV., p. 356.

with a request addressed to me, to give a short account of my visits to two of the most remarkable regions to be found in this or in any other country. I allude, in the first place, to the great volcanic zone in the North Island, including the famous Hot Lakes and Springs; and, secondly, to Milford Sound, and the other grand and wondrous inlets of the south-west coast of the Middle Island. On the present occasion, I have been requested to contribute some descriptions of the great Lake of Taupo and of the surrounding districts, which I visited on my recent journey overland from Wellington to Auckland, across the centre of the North Island. As it has been previously remarked, "the official tours of a Governor may be made practically useful, for they enable him to point out from personal knowledge, and in an authoritative shape, the resources and capabilities of the several districts of the Colony over which he presides, and the advantages which they afford for immigration, and for the investment of capital." It is well known that the published reports of my journeys throughout all the Provinces of New Zealand have attracted much attention in the mother country; and that Her Majesty's Government have thought it right, in the interests of this community, to give them wide and official circulation by presenting them to the Imperial Parliament.

I approached the Lake of Taupo from Napier, which I left on the 6th of last April. On that evening we reached the first post of the Colonial Forces at Te Haroto, thirty-five miles from the port, after passing over an undulating country of hill and valley, which, now that permanent tranquillity appears to have been established, will soon be occupied by settlers. Te Haroto is a strong position, 2,200 feet above the sea, on a high hill, which commands an extensive and magnificent prospect of the open ocean and of the coast, as well as of the wild mountains and forests of the Urewera country. On the following day we rode from Te Haroto to Opepe, a distance of forty-two miles, over much rich land, and through some beautiful scenery of hill and woodland, which reminds the European traveller of the Apennines and of the Italian slopes of the Alps, though the semi-tropical luxuriance of the New Zealand forests far surpasses the vegetation of the Old World. It was at Opepe that, in June, 1869, a detachment of the Colonial Forces was surprised and cut to pieces by Te Kooti. On the 8th we left Opepe; at a distance from which of some twelve miles we reached Tapuaeharuru, the native pa at the north end of the Lake of Taupo, near the spot where the River Waikato issues from it with tremendous speed and force. Here the Governor was received with much enthusiasm by the Maoris of the Ngatituwharetoa clan, headed by the loyal chief Poihipi Tukairangi, one of the last survivors of those who signed the Treaty of Waitangi in 1840; and one of the few chiefs of the central districts of this island who have remained throughout stedfast in their allegiance to the Queen.

The name Tapuaeharuru signifies "echoing footsteps," and has reference to the hollow sound of the earth in this neighbourhood, owing to the hard superficial crust formed by the volcanic soil over the deep and vast caverns beneath. Along both banks of the Waikato there are numerous solfataras and geysers, which throw up constantly white clouds of steam, and, ever and anon, jets of boiling water. The extinct volcano of Mount Tauhara is a picturesque object rising above the right bank of the river. Below it, the north end of the lake is bounded by the Kaingaroa Plain, by old streams of lava from Tauhara, and by terraces of pumice-stone, varied by groves of manuka, resembling gigantic and evergreen heather. To the Southward stretches bright, broad, and long, the great Lake, or—as it is called by the Maoris*—the Sea of Taupo, realizing Virgil's description of the Lago di Garda, the Benacus of ancient Italy :—

"Fluctibus et fremitu assurgens, Benace, marino." †

Taupo is indeed a noble inland sea, the Queen of the lakes of the North Island, with its coast formed mainly by dark and lofty cliffs, grand in their gloom, but relieved here and there by a mountain torrent or a glittering waterfall. At the southern horizon the prospect is bounded by the graceful outline of the peaks of the Kaimanawa range; to the west of which towers the great active volcano of Tongariro,‡ with its ever-steaming crater of Ngauruhoe; and near it, clad in perpetual snow, the huge mass of Ruapehu.§

The Lake of Taupo is about 1,200 feet above the sea-level, and somewhat resembles in climate and scenery, as well as in extent (covering about 200 square miles of water), the Lake of Geneva. It is in most parts of hitherto unfathomed depth, and its waters have, probably, filled and overflowed several ancient craters. It is on nearly all sides surrounded by masses of lava, pumice-stone, and other volcanic formations, rising, more or less abruptly, into a high and generally barren table-land. Not far from the centre of the lake is the rocky islet of Motutaiko, celebrated in Maori legend as the abode of the *Taniwhas*—the malignant water-fiends, whose spite often stirs up the fierce and sudden gales which render so dangerous the navigation of the "Sea" of Taupo.

On the 9th April, we started in a boat for Tokano, the principal native settlement at the south end of the lake. The distance by water is about twenty-six miles, and by land, along the eastern shore, about thirty-six miles. The morning was calm and bright, but at noon a strong contrary gale arose; so we landed at the site of the old Pa of Motutere, whither horses had been sent forward in anticipation of one of these sudden storms. Thence, we rode the rest of the distance (about sixteen miles) to Tokano, chiefly along the margin of the lake; fording, however, several rivers which flow into its

* The Maoris speak of the *Moana* (*i.e.* sea), not *Roto* (*i.e.* lake) of Taupo.

† Virgil, Georg. II., 160. ‡ About 6,500 feet high. § About 9,200 feet high.

southern extremity; among them the Upper Waikato, which, in this portion of its long course, is generally called by the natives the river of Tongariro. On our arrival at Tokano, as everywhere else on my tour, I was welcomed with hearty respect and good-will by the local chiefs and their clansmen. Our party was lodged in several Maori whares, and food was liberally provided, in the absence of the supplies shipped on board our boat.

We bathed that evening, by moonlight, in one of the many natural basins into which overflow the Hot Springs, that seethe and boil amid and around the *kainga*, or native village, of Tokano. In these fairy baths—with sides as of polished marble, and bottoms as of glazed porcelain—meet, each evening, the Maoris, old and young; while from every quarter are heard gay chants and songs. "But," to quote the graphic description of a recent traveller,* "ever and again, even these voices are hushed and stilled, while, with a weird and rushing sound, the great geyser bursts from the calm waters, rising white and silvery in the moonbeams which reveal the dark outlines of the distant hills, and dashing its feathery spray high against the starry sky."†

The southern shores of Lake Taupo are the most fertile and attractive. Near its south-western extremity is the Pa of Pukawa—the residence during many generations of the family of Te Heuheu, one of the most powerful among the old Maori aristocracy. The father of the present chief perished by an awful catastrophe in May, 1846, in the neighbouring village of Te Rapa, on the shore between Pukawa and Tokano. He was buried alive during the night, together with sixty of his clansmen, by a landslip, or rather by an avalanche of boiling mud. To quote Hochstetter:‡ "Above the springs on the side of the mountain, probably 500 feet above the lake, steam issues from innumerable places. The whole north side of the Kakaramea mountain seems to have been boiled soft by hot steam, and to be on the point of falling in. From every crack and cleft on that side of the mountain, boiling water streams forth with a continual fizzing noise, as though hundreds of steam-engines were in motion. These steaming fissures in the mountain side, upon which every stone is decomposed into reddish clay, are called by the natives *Hipaoa*, *i.e.*, the chimneys; and it was at the foot of this mountain that, in the year 1846, the village of Te Rapa was overwhelmed by an avalanche of mud, and the great Te Heuheu perished." Hochstetter adds that the corpse of their chief was afterwards exhumed by his clansmen from the buried village, and accorded a solemn interment. "According to Maori custom in the case of great chiefs, the remains were disinterred after some years, laid out upon a kind of bed of state, and preserved in a magnificently carved

* Lieut. the Hon. Herbert Meade, R.N.; see, "A Ride through New Zealand," chap. ii.

† The largest geyser at Tokano is called Pirori. The water is here sometimes thrown to a height of more than forty feet.

‡ Hochstetter's "New Zealand," chap. xvii.

coffin. The sacred remains were intended to be then conveyed to the summit of Tongariro; for the deep crater of the volcano was designed to be the final grave of the hero, with the heaven-ascending pyramid of scoriæ and ashes for his monument. But this grand idea was only half carried out. As the bearers were approaching the top of the ever-steaming cone, a subterraneous roaring noise became audible, and, awe-struck, they deposited their burden upon a projecting rock. There the remains still lie. The mountain, however, is most strictly *tapu*, and nobody is allowed to ascend it."

On the morning of the 10th of April we started on horseback, escorted by the principal chiefs, for Rotoaira, a small and pretty lake at the foot of Tongariro, and about ten miles north of Tokano. At first we rode over the rich alluvial delta formed by the Upper Waikato where it flows into Taupo, and which is in part cultivated by the natives. Then, turning to the right, we skirted the wooded base of Pihanga, the hill renowned in Maori legend as the spouse of Tongariro. The native tradition runs that of yore three mighty giants, Tongariro, Taranaki, and Ruapehu—like Pelion, Ossa, and Olympus—stood side by side, until Taranaki attempted to carry off Pihanga, his brother's wife. Then arose a combat like that in the classical mythology between the Gods and the Titans; in which the false Taranaki was at length worsted and forced to fly, drawing after him the deep furrow of the river Wanganui. His flight was stayed only by the western ocean, where he now stands on the shore in solitary and mournful grandeur, his hoary head covered with perpetual snow,—the magnificent cone of Mount Egmont.*

The scenery of this region is very fascinating. The bleak shores of the Lake of Taupo are, for the most part, little fitted for European settlement; but from under Tongariro and Ruapehu, stretch away East, West, and South, well-grassed and well-watered valleys, separating mountain ranges that wave with primeval forests. As yet, there is scarcely any sign of human habitation, past or present, in this glorious country; but the native owners are already in treaty to lease large portions of it to English settlers. As we stood together on the lower slopes of Tongariro, one of the Maori lords of the soil, after casting a proud glance over his wide domains, turned to me and said that he had lived through many changes, that he remembered the first settlement of the white strangers in New Zealand, and that he now cherished the hope that the rents of the broad lands of his ancestors would enable him to spend his old age in peace, and to educate his children in the language and arts of the English. He longed before he died to see the fair valleys and plains, now lying silent and untenanted before us, overspread by herds of cattle and flocks of sheep; with English homesteads and townships rising up along the rivers and in the glades of the forests; and with steamboats, bearing the

* So Captain Cook named the Taranaki of the Maoris.

comforts and luxuries of civilized life over the now lonely lakes. I thought of the speech of Longfellow's Red Indian Chief, Hiawatha:—

"I beheld too in that vision
All the secrets of the future,
Of the distant days that shall be.
I beheld the westward marches
Of the unknown, crowded, nations.
All the land was full of people,
Restless, struggling, toiling, striving.
Speaking many tongues, yet feeling
But one heart-beat in their bosoms.
In the woodlands rang their axes,
Smoked their towns in all the valleys:
Over all the lakes and rivers
Rushed their great canoes of thunder."

A very remarkable feature in this region of transcendent interest, is the volcanic *plateau*, of which Tongariro and Ruapehu are the main summits, for it forms a central watershed from which the five chief rivers of this Island flow down in their several courses to the sea. Here, within a space of a few miles, are the sources of the Waikato, the Mangawhero, the Wangaehu, the Turakina, and the Rangitikei.† While riding in the shadow of Tongariro, I was forcibly reminded of my early travels in Eastern Europe, and of my visit, in 1849, to the famous Pass and Mountain of Lacmos‡ in the range of Pindus, between Thessaly and Epirus; whence issue the five principal rivers of Northern Greece, viz., the Aous, the Peneus, the Arachthus, the Haliacmon, and the Achelous. This is one of the many geographical parallels between Greece and New Zealand which must strike every classical scholar who has travelled in both countries. It has been said that the stirring scene presented under the dome of St. Paul's on the day of the National Thanksgiving in last February has indefinitely postponed the advent of Macaulay's New Zealander to sketch the ruins of the cathedral from a broken arch of London Bridge; but, perhaps, it is not too much to hope that meanwhile there may arise in New Zealand a poet who will paint of the great mountain reservoir of this Island a word-picture, not altogether unworthy to be compared with that noble and original picture which Virgil, in his Fourth Georgic, has drawn of the vast subterranean grotto at the source of the Peneus, in which Aristæus was welcomed by Cyrene, his goddes-mother, and by her train of nymphs;

Longfellow's "Hiawatha," xxi.

† These streams, and the country on their banks, are described in the fourth volume of the *Transactions* of the Institute (now under review), pages 128–135, in an article "On the Geographical and other Features of some little known portions of the Province Wellington."—By Mr. H. C. Field.

‡ Now called Zygos.—See Leake's "Northern Greece," chap. ix.

and whence he beheld the mighty rivers gliding by hidden channels, amid the rush and roar of many waters :—

> "Jamque domum mirans genetricis, et humida regna,
> Speluncisque lacus clausos, lucosque sonantes,
> Ibat, et ingenti motu stupefactus aquarum,
> Omnia sub magna labentia flumina terra,
> Spectabat diversa locis." —

On the day succeeding that of our return to Tupuaeharuru, we visited Te Huka (*i.e.*, "the foam,") Waterfall, at the distance of about four miles from the north end of the Lake of Taupo. As Lieut. Meade remarks,† "This cascade is grand in a style of its own, though not remarkable for great height or breadth." Some 300 yards above the Fall, the Waikato is contracted into a narrow chasm with almost perpendicular walls, between which the whole body of the river dashes, in a cloud of snowy foam and with a deafening roar, over the rocky brink into the deep blue basin, with its whirling eddies, beneath. From the crevices of the precipitous cliffs around, numerous tree-ferns spread their feathery fronds ; here, too, the Toe-Toe grass‡ hangs its silken flags amid the violet-blooming Koromiko,§ and all the brightly chequered copse of New Zealand. The wave-worn terraces of the volcanic hills above bear, stamped on their slopes, the traces of the action of fire and water in remote ages.

From Tupuaeharuru, it is a ride of twenty-five miles to Orakei-korako, a village of the Ngatiraukawas, strongly situated on a hill overhanging the rapids and cataracts of the Waikato, and nearly opposite the famous alum-caves on the right bank of that river. In the words of Mr. Meade ‖ :—"The whole of the hills and woods, visible from the crest where the *kainga* is built, are dotted with hundreds of steam-jets, whose wreaths and clouds of steam keep curling up from amidst the branches of the trees, giving a very singular character to a very beautiful landscape."

I regret that time and space will not allow me to give, on the present occasion, any further description of my journey overland from Taupo to Auckland. In the address of last year, I laid before the Institute some account of my then recent visit, in company with the Duke of Edinburgh, to the wonders of Rotorua and Rotomahana. This year I have followed the long course of the Waikato—that noble river, which is to the Maoris what the Rhine is to the Germans—almost from its source, near the foot of Tongariro in the centre, to the spot where it flows into the sea, on the West Coast of this Island.

I would refer to the Parliamentary Papers, and to other official records, those who may desire information respecting the favourable effect on the

* Virgil, Georgic iv., 363–367. † Chap. iii. ‡ *Arundo conspicua.* Forst.
§ *Veronica salicifolia.* Forst. ‖ Chap. iii.

Maoris of my journeys through the recently hostile and disaffected districts; and also respecting the progress of the roads which—carried out, in great measure, by native labour—are gradually, but surely, opening up to peace and to civilization the mountains and forests of the interior. Our learned associate, Mr. Travers, has truly remarked, in one of his contributions to the last volume of our *Transactions*, that the public works undertaken by the Colonial Parliament will "afford invaluable opportunities of pushing on inquiries in various branches of the Natural History of New Zealand, in a manner, and with a rapidity, which we could otherwise scarcely have hoped for. The construction of lines of road and railway through tracts of country hitherto comparatively unknown, will give to the geologist and botanist, to the miner and agriculturist, and indeed to all who are engaged, either theoretically or practically, in inquiring into or in developing the resources of the Colony, the greatest facilities for carrying out their objects; and we may look forward, in this aspect of the matter, to results of the highest importance."

In conclusion, gentlemen, I beg to thank you for the indulgence with which on this, as on four previous occasions of a like character, you have listened to a somewhat desultory address. I assure you, in all sincerity, that among the many delightful recollections of New Zealand which I shall cherish during the remainder of my life, not the least satisfactory will be the remembrance of my connection, as the first President, with this Institute and its members.

Fourth Annual Report by the Governors of the New Zealand Institute.

Meetings of the Board of Governors were held during the past year on the 24th August, 12th September, 1st November, 1871; and 28th February and 11th April, 1872.

The following gentlemen were re-nominated to be Governors:—W. T. L. Travers, F.L.S., and Charles Knight, F.R.C.S.; and a vacancy occasioned by the retirement of J. E. Fitzgerald, C.M.G., has not yet been filled up.

The Governors elected by the affiliated Societies for the present year are:—His Honor William Rolleston, the Hon. W. B. D. Mantell, His Honor Mr. Justice Chapman.

On the 11th April, 1872, Alfred Ludlam, Esq., resigned the honorary Treasurership, and the Hon. W. B. Mantell, M.L.C., accepted the office.

In accordance with the provisions of Statute IV., three foreign members were elected; namely, J. E. Gray, Ph.D., F.R.S., Charles Darwin, M.A., F.R.S., William Lauder Lindsay, M.D., F.R.S.E.

The Institute now includes five affiliated Societies; the total number of members being 577, showing an increase of 24 on last year.

	Members.
Wellington Philosophical Society	132
Auckland Institute	157
Philosophical Institute of Canterbury	81
Otago Institute	136
Nelson Association	71

The appended statement of accounts shows the manner in which the endowment of the Institute has been applied.

The fourth volume of the *Transactions and Proceedings* was issued in May last. It consists of 472 pages, and contains sixty-four original communications by forty-five authors, illustrated by nineteen lithographed plates. Of these papers, nineteen are on zoology, twelve on botany, nine on chemistry, three on geology, and nineteen on miscellaneous subjects.

The Board of Governors having decided that, in publication, preference is to be given to those papers which add to the knowledge of observed facts relative to New Zealand, several papers of a general character have been held back, or only published in an abridged form.

The supply of volumes now in store is as follows:—Of Volume I., none; Volume II., 58; Volume III., 53; Volume IV., 74 copies.

The report of the Manager on the condition of the Museum and other establishments placed under his direction, is appended. It shows that valuable additions have been made to the collections in the Museum during the past year, but that the want of sufficient exhibiting space has rendered it necessary to remove a large portion of those additions from exhibition to the public. On this point the Governors feel it to be their duty to point out that the collections in the Museum cannot be properly exhibited, so that the public may derive full advantage from them, without the completion of the building as originally designed.

The Governors also call attention to the expediency of increasing the staff of the Colonial Museum, especially as regards the preparation of articles of Natural History, so that collections of such objects may be distributed to the various Educational Institutions of the Colony in a form calculated to aid in the work of instruction in Natural History.

G. F. Bowen, President.

Wellington, 19th September, 1872.

Accounts of the New Zealand Institute, 1871–72.

Receipts.	£	s.	d.	Expenditure.	£	s.	d.
Balance in hand	94	17	5	Expenses of Volume IV.	391	15	0
Vote for 1871–72	500	0	0	Miscellaneous—Translating, Binding, etc.	28	9	6
Contribution from Wellington Philosophical Society	12	18	6	Balance in hands of Treasurer	195	13	5
Sale of Volumes of *Transactions*	8	2	0				
	£615	17	11		£615	17	11

Walter Mantell,
Honorary Treasurer.

17th September, 1872.

Report by Manager.

Museum.—The collections in the Museum have been increased during the past year by the addition of 2,169 specimens.

Birds.—The collection of New Zealand birds is now tolerably complete, and has been arranged in a suitable cabinet for reference, there being only a few of the specimens set up for exhibition.

Very extensive collections of birds from various parts of the world have now accumulated, which it has been found necessary to place in drawers and packing cases, so that at the present time they are inaccessible to the public, and inconveniently difficult of access for reference.

The most extensive recent addition to the collections in this department has been that purchased from Mr. H. Travers, which consists of thirty-seven species and 192 specimens from the Chatham Islands, some of which are new to science or extremely rare.

A collection of seventy birds of California has also been presented by the Academy of Natural Science in San Francisco; 114 birds' skins from Norway, presented by Mr. J. Graff; forty-one European birds' skins, forwarded by Dr. Buller; and fifty-seven specimens of birds are on their way from Germany, having been sent in exchange by Dr. O. Finsch.

The New Zealand birds' eggs have been mounted for exhibition, and the collection has been enriched by the donation of fifty-six specimens of the eggs of British birds, by Mr. T. H. Potts.

The illustrated work on New Zealand birds, by Dr. Buller, referred to in last year's report, is advancing through the press, the first two, out of the five parts of which it consists, having reached the Colony, and the remainder of the work is, I am informed by the author, already in the printer's hands.*

The Catalogue of the Birds, with the diagnoses of the species, by Captain Hutton, also referred to in last report, was issued in October last.†

Fishes.—A collection of forty-six stuffed specimens, and forty-one skeletons of the fishes of New Zealand, and ninty-two species preserved in spirits, has been prepared and arranged for exhibition, to illustrate this important branch of the Natural History of the country.

The number of fishes now known to belong to New Zealand is 147 species, of which only about fifteen are not represented in the above collection.

The distinctive characters of the species have been given by Captain Hutton, together with notes on the edible species by myself, in a work issued from this department in May last.‡

I should also mention the valuable Osteological preparations which have been made for the Museum by Dr. Knox, among which the following are the most important:—Skeletons of a Moriori (female), the Sea Leopard,

* "Birds of New Zealand," by W. L. Buller, Sc.D., 4to., with coloured plates of all the species peculiar to the Islands.—Van Vorst, London.

† "Catalogue of the Birds of New Zealand," by Captain Hutton, F.G.S., Assistant Geologlst, 8vo., 85 pp.

‡ "Fishes of New Zealand," Catalogue by Captain F. W. Hutton, F.G.S., Assistant Geologist, and Notes on the Edible Fishes, by Dr. Hector, Director, with 12 plates, 8vo., 135 pp.

(*Stenorhyncus leptonyx*), thirty birds, fifty fishes, twenty reptiles, etc., constituting a most interesting feature in the Museum.

Shells.—The collections of New Zealand shells, both recent and fossil, have been thoroughly investigated by Captain Hutton, the greater part of whose time during the past year has been devoted to this important work, and he has prepared a descriptive catalogue, which only awaits the receipt of a list of the New Zealand shells in the European collections, which is being prepared by Dr. Von Martens, of Berlin, to be completed for the press.

The total number of existing species of the class Mollusca, represented in the Museum, and described in this catalogue, will be 560; to which must be added 200 species of fossil shells that are now extinct.

Captain Hutton has also prepared a descriptive catalogue of the New Zealand *Echinodermata* in the Museum, in which he enumerates thirty-six species.

The collection of foreign shells has been added to, during the past year, by 170 American species, presented by Colonel Jewett, of New York, and other collections of minor importance.

Insects.—An arrangement is being made for the publication in England of descriptive and illustrated catalogues of the different classes of insects which are found in New Zealand, as their classification cannot be satisfactorily effected without reference to extensive Museums and Libraries containing works of reference in Natural History. The foreign collections in the Museum have received a valuable addition in a named collection of 332 specimens of the *Lepidoptera* and *Coleoptera* of Queensland, from W. H. Miskin, Esq.

Palæontology.—The descriptive and illustrated catalogue of the New Zealand fossils in the Museum is also in an advanced state of preparation; but further examination of certain localities will be necessary before it can be sent to press. The collection of minerals, rocks, and fossils, has been largely extended during the past year, in the course of the Geological Survey; the chief additions being the collections made in Canterbury by Dr. Haast, and Mr. H. Travers in the Chatham Islands and at the Amuri, where he obtained a large number of Saurian bones, in blocks that weigh several hundredweight, but unfortunately in a very hard matrix, so that it is doubtful if they can be extracted in a perfect state.

The chief special collections which have been added to the Herbarium during the past year, besides the plants of the neighborhood, which are constantly being collected by Mr. Buchanan, are specimens illustrating the botany of the Hot Lake and North Taupo Districts, which have been reported on for the Department by Mr. T. Kirk, F.L.S.

An almost exhaustive collection of the botany of the Chatham Islands has

been obtained by Mr. H. Travers, ten sets of which will be available for exchange as soon as they have been reported on by Baron Von Müeller, to whom a complete series has been sent in duplicate for this purpose. The only foreign collections of dried plants received during the past year, have been of Sandwich Island plants, from Dr. Hildebrand, and a collection of British *Algæ*, prepared and presented by Mrs. J. E. Grey.

The Herbarium now contains, in addition to the Colonial Flora, a very complete set of British flowering plants and ferns, also ferns of New Hebrides, Sandwich Islands, and Fijis.

The chief desiderata necessary to make the Herbarium sufficiently complete for the New Zealand student, are the plants of Eastern Australia and Tasmania.

For convenience of reference, a complete set of New Zealand and British plants is being mounted in books and placed in the library.

Laboratory.—Analyses have been performed during the year by Mr. Skey, to the number of 285, making a total of 1,203 analyses entered in the Laboratory books.

In addition to the analyses of minerals and ores of various kinds, a very large portion of the Analyst's time is occupied with examinations of samples submitted by the Secretary of Customs, under the Distillation and Gold Duty Acts; and the responsibility of the verification of standards, required under the Weights and Measures Act, is also performed for the Colony in connection with this department.

During the past year, sixty lithographic plates have been prepared to illustrate the various publications issued by the department; and about thirty-three original drawings made of objects of natural history and fossils, with a view to future publication.

A general geological map of the Colony, on a scale of twelve miles to the inch, is also in progress.

The small-scale geological map, referred to in last year's report, has now been printed off and distributed, 150 copies having been sent to Professor Owen, at his request, for incorporation with a work which he is publishing on the Extinct Struthious Birds of New Zealand.

The Geological Survey field work has been chiefly directed during the past season to the development of the coal deposits, in accordance with the Public Works Act; the examination of the coal fields on the West Coast of Nelson having been undertaken by myself; those in the Southland District and in the North of Auckland by Captain Hutton; while the coal deposits on the eastern side of the South Island, in Canterbury and Otago, have been examined by Dr. Haast. The chief practical results of the surveys have been published through the Public Works Department, but the extensive additions

they have made to the general geological survey of the Colony will be found in the various reports issued from the department for the current year.

Observatories.—The Meteorological Department, and the Astronomical Observatory, for regulating the mean time for the Colony, both of which are under my direction, are in an efficient condition, the statistical information being published regularly, and exchanged with the chief Observatories in other parts of the world.

JAMES HECTOR.

TRANSACTIONS.

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE,

1872.

I.—MISCELLANEOUS.

Art I. — *On the Life and Times of Te Rauparaha.* By W. T. L. Travers, F.L.S.

[*Read before the Wellington Philosophical Society, 21st August, 4th September, 2nd, 9th, and 30th October,* 1872.]

Chapter I.

The position occupied by the great chief Te Rauparaha in connection with the establishment and earlier progress of the New Zealand Company's settlements in Cook Straits, would alone justify us in recording all that can still be learnt of the career of this remarkable man; but when, in addition to the interest which his personal history possesses for us in this respect, we find that he took a very important part in the events that occurred in these Islands between the years 1818 and 1840—leading as they did to an immense destruction of life amongst the then existing population, and to profound changes in the habits and character of the survivors—it becomes important, for the purposes of the future historian of the Colony, that we should preserve the most authentic accounts of his career, as well as of that of the other great chiefs who occupied, during the period in question, positions of power and influence amongst the leading New Zealand tribes. As with Hongi, Te Waharoa, and Te Wherowhero in the North, so Te Rauparaha in the South carried on, during the interval referred to, wars of the most ruthless and devastating character, undertaken partly for purposes of conquest, and partly for the gratification of that innate ferocity for which the New Zealanders have long been remarked. His own immediate tribe, the Ngatitoa, though insignificant in point of numbers, when compared with most of the leading tribes of the North Island, had long been celebrated for their prowess as warriors; and the reliance they placed upon the sagacity

and valour of their chief added to the prestige of frequent victories, and, above all, to the confidence inspired by the possession of new and powerful weapons, unknown, in most cases, to their earlier opponents, led them unhesitatingly to engage in enterprizes, the difficulties and dangers of which might otherwise well have deterred even bolder men. Nor was the special confidence inspired by the possession of firearms at all surprising, when we remember the extraordinary results which have recently been brought about, even amongst European nations, by mere improvements in the construction of the weapons used in warfare. In the case of Austria, for example, the power of one of the greatest military nations of the world was almost annihilated, and has certainly been permanently reduced, in consequence of the possession, by their recent adversaries, of weapons of somewhat greater precision than their own. We cannot, therefore, wonder at the results which would be produced upon even the most warlike savage people, where the arms on the one side were muskets, and on the other mere clubs and wooden spears and more especially where those who used the latter had had no previous knowledge of the destructive power of the more deadly weapons brought against them. My narrative will, indeed, often recall the graphic language of De Foe when describing the effect produced by the guns of Robinson Crusoe and Friday upon the savages engaged in butchering their prisoners: "They were, you may be sure," he says, "in a dreadful consternation, and all of them who were not hurt jumped upon their feet, but did not immediately know which way to run or which way to look, for they knew not from whence their destruction came." We shall find, in effect, that this was the principal reason why the wars carried on by Te Rauparaha were, notwithstanding the smallness of his own forces, quite as disastrous to the numerous tribes which occupied the scenes of his exploits, as those which were waged against their own neighbours by the more powerful chieftains in the northern parts of the country, and that Te Rauparaha contributed as largely as most of the former to the enormous destruction of life which took place during the two-and-twenty years above referred to. But before entering upon the immediate subject of this memoir, I have thought it desirable to compile a short account, showing—the habits and character of the New Zealanders; their laws in relation to the acquisition and ownership of land; their customs in war; the general condition of the tribes before the introduction of firearms, and the effects which that circumstance in their history produced upon them. I have thought it would be satisfactory to my readers that I should adopt this course, not merely as a matter of speculative interest, but because some knowledge upon these subjects will really be found necessary to a full appreciation of the events I propose to relate, and of the characters of the chief actors in those events.

I propose in the present chapter to inquire, shortly, into the habits and

customs of the New Zealanders in especial relation to the ownership of land, and to war, and then to offer some observations regarding their social and individual characteristics; and I may at once say that in compiling the following notice of these matters I have availed myself largely of Mr. White's "Lectures on Maori Customs and Superstitions," and of Mr. Colenso's "Essay on the Maori Races," which, though by no means exhaustive, are sufficient to enable those who have had any opportunities of personal observation, and who may, therefore, read them by the light of locally acquired knowledge, to obtain reasonably clear ideas upon these points. It would appear from the facts collected by these and other writers, and from the traditions of the New Zealanders themselves, that from the very earliest times they clearly understood the value of the possession of land. This was, of course, naturally to be expected in a people dependent upon the cultivation of the soil for a considerable proportion of their ordinary means of subsistence, for although New Zealand, as a rule, is a fertile country, and possesses a mild climate, and is almost everywhere covered with a dense vegetation, its natural vegetable productions, suitable for the proper sustenance of man, are extremely limited; and the Natives would often have suffered from want if they had been wholly dependent for their supplies of food upon the indigenous vegetation, and upon the uncertain results of their rat-chases and their fisheries. No doubt, whilst the Moa still abounded in various parts of both Islands, it afforded them a better class of animal food than any other they possessed before the introduction of the pig, but we have no positive information as to the date at which this source of supply failed them, nor do I think the materials for the determination of this question are at all likely to lead to any certain results upon the point. There can be no doubt, indeed, that long before the time of Cook, the most valuable articles of food used by the Maoris were not indigenous, as, for example, the Kumera (*Convolvulus chrysorhizus*), the Taro (*Caladium esculentum*), and the gourd-like Hue, in the growth of each of which a special and most careful mode of treatment was necessary. We find, accordingly, that a very large part of the time of the people of all classes was taken up in these cultivations, as well as in the preparation of such indigenous substances as were at all suitable for food; for, independently of the immediate family wants, the hospitalities of the tribes—to which all the members must necessarily contribute, especially on solemn occasions—led to the expenditure of large stores of provisions. As I have before observed, it was natural that a people, whose ordinary wants necessitated the cultivation of the soil to any large extent, should attach great value to the possession of land; and we find, in effect, that every tribe claimed its own special domain, and preserved the most accurate knowledge of the extent and limit of its territorial rights.

"There is no point," says Mr. White, "on which a New Zealander's

indignation can be more effectually roused than by disputing his title to land. This love for his land is not, as many would suppose, the love of a child for his toys; the title of a New Zealander to his land is connected with many and powerful associations in his mind. He is not, of course, what we call a civilized man, but in dealing with him we deal with a man of powerful intellect, whose mind can think and reason as logically on any subject with which he is acquainted, as his more favoured European brethren, and whose love for the homes of his fathers is associated with the deeds of their bravery, with the feats of his boyhood, and the long rest of his ancestors for generations. The New Zealander is not accustomed to law and parchment, or to wills and bequests, in gaining knowledge of or receiving a title to the lands of his fathers; nor would he quietly allow any stranger to teach him what lands were his, or what lands were not; what were the names of the boundaries, the creeks, mountains, and rivers in his own district. The thousand names within the limits of his hereditary lands were his daily lesson from childhood. The son of a chief invariably attended his father, or his grandfather, in all his fishing, trapping, or spearing excursions; and it was in these that he learnt, by occular demonstration, the exact boundaries of his lands, and especially heard their various names. It was a custom with the Maoris in ancient times to eat the rat—a rat indigenous to this country, and caught in traps set on the tops of the mountain ranges. This was a source of part of their daily food, and it was therefore, with them, a point of great importance to occupy every available portion of their lands with these traps; and as most of the tribal boundaries are along the range of the highest hills or mountains, and as these were the common resort of the rat, every New Zealand chief soon naturally became acquainted with the exact boundary of his land claims. He did not, however, limit these claims to the dry land—they extended to the shellfish, and even out to sea, where he could fish for cod or shark, or throw his net for mackerel; nor did he go inadvertently to these places, and trust to chance for finding his fishing grounds—he had land-marks, and each fishing-ground and land-mark had its own peculiar name; these to him were more than household words; his fathers had fished there, and he himself and his tribe alone knew these names and land-marks. Where a creek was the dividing boundary of his lands this was occupied by eel-dams. These dams were not of wicker-work, that might be carried away by a flood—labour and art were bestowed upon their construction, so that generations might pass, all of whom in turn might put their eel-basket down by the carved and re-ochred totara post which their great grandfather had placed there. When the dividing boundary between two tribes ran along a valley, land-marks were put up; these consisted generally of a pile of stones or a hole dug in the ground, to which a name was given significant of the cause which gave rise to such boundary being agreed

to; such, for instance, as Te Taupaki—the name given to the dividing boundary on the West Coast between the Ngatiwhatua and Tainui tribes—which means the year of peace, or the peaceful way in which a dispute is adjusted. This boundary had its origin from a chief of the Ngatiwhatua, called Poutapuaka, going from Kaipara to take possession of land with his paraoa, or bone spear. His intention was to go along the coast as far as the quantity of food which he carried would enable him to travel, and return from the point at which his food was expended; he had succeeded in taking possession of the whole of the line of sandy coast called Rangatira, and on arriving at the top of the hill, now known as Te Taupaki, he met the Tainui chief Haowhenua. They both halted, sticking their spears in the ground, and inquiring of each other the object of their being there. They found that they were both on the same errand, and at once agreed that this meeting point should be the boundary dividing the lands of the tribes whereof each was the representative. The Ngatiwhatua chief at once dug a hole with his bone spear, and the boundary so established has remained to this day. I may state," adds Mr. White, "without fear of contradiction, that there is not one inch of land in the New Zealand Islands which is not claimed by the Maoris, and I may also state that there is not a hill or valley, stream, river, or forest, which has not a name—the index of some point of the Maori history. As has been stated above, the New Zealander knows with as much certainty the exact boundary of his own land, as we could do from the distances and bearings given by a surveyor. But these boundaries are liable to be altered at times; for instance, when lands are taken by a conquering tribe, or are given by a chief for assistance rendered to him by another tribe in time of war, or when land given to the female branch of a family again becomes, after a certain time, the property of the male branch of the family. In certain cases,, also lands are ceded by a tribe for a specific purpose, with certain restrictions, and a tenure conditional on certain terms being complied with."

Mr. Colenso, in his "Essay on the Maori Races," tells us that their views of property were, in the main, both simple and just, and in some respects (even including those most abnormal) wonderfully accorded with what once obtained in England. Amongst them, property was usually divided into two classes, namely, peculiar and common. Every man, for example, had a right to his own, as against every one else, although this right was often overcome by might. A man of middle, or low rank, caught, perhaps, some fine fish, or was very lucky in snaring birds—such were undoubtedly his own; but if his superior, or elder chief, wished or asked for them, he dared not refuse, even if he would. At the same time, such a gift, if gift it might be termed, was (according to custom) sure to be repaid with interest, hence it was readily yielded. The whole of a man's movable property was also his own, which

included his house and fences, as well as all his smaller goods. All that a freeman made or caught, or obtained, or raised by agriculture, were his own; although his house, created by himself, was his own, yet if not on his own land (rarely the case) he could not hold it against the owner of that spot, unless such use had been openly allowed to him by the owner before all (*i te aroaro o te tokomaha*). So a plantation planted by himself, if not on his own land (also a rare thing), he would have to leave after taking his crops, on being ordered so to do; but not so if he had originally, and with permission, felled the forest, or reclaimed that land from the wild; in which case, he would retain it for life, or as long as he pleased, and very likely his descendants after him. To land, a man acquired a peculiar right in many ways:—

1. Definite.—(*a.*) By having been born on it, or, in their expressive language, "where his navel string was cut," as his first blood (ever sacred in their eyes) had been shed there. (*b.*) By having had his secundines buried there (this, however, was much more partial). (*c.*) By a public invitation from the owner to dwell on it. (*d.*) By having first cultivated it by permission. (*e.*) By having had his blood shed upon it. (*f.*) By having had the body or bones of his deceased father or mother, or uterine brother or sister, deposited or rested on it. (*g.*) By having had a near relative killed or roasted on it. (*h.*) By having been bitterly cursed in connection with that piece of land, *i.e.*—this oven is for thy body, or head; on that tree thy liver shall be fixed to rot; thy skull shall hold the cooked birds, or berries of this wood. (*i.*) Or by the people of the district using for any purpose a shed which had been temporarily put up there, and used by a chief in travelling.

2. Indefinite.—(*a.*) By having been invited to come there by the chief with a party to dwell (*lit.*, having had their canoe in passing called to shore). (*b.*) Through his wife by marriage; but such would only be a quasi life-interest to him, *i.e.*, during her life and infancy of the children, as, in case of children, they would take all their mother's right. (*c.*) By having assisted in conquering it. (*d.*) By having aided with food, a canoe, a spear, etc., an armed party who subsequently became conquerors of it. All these equally applied, though he should belong to a different tribe or sub-tribe.

3. Beyond all these, however, was the right by *gift* or *transfer*, and by *inheritance*, which, not unfrequently, was peculiar and private. This (which has of late years been much contested, and too often, it is feared, by ignorant and interested men, or by those who have too readily believed what the talkative *younger* New Zealanders *now* say,) may clearly be proved beyond all doubt:—(1.) By the acts of their several ancestors (great-grandfathers) to their children, from whom the present sub-tribes derive their sub-tribal names, and claim their boundaries; such ancestors divided and gave those lands simply to

each individual of their family, which division and alienation, however unfairly made, has never been contested. (2.) By their ancient transfers (gifts or sales) of land made by individuals of one tribe to individuals of another, as related by themselves; and from which gift or alienation, in many instances, they deduce their present claims. (3.) By their earliest (untampered) sales and transfers of land to Missionaries and to others, which were not unfrequently done by *one* native (as was notably the case in the *first* alienation of land by deed to Mr. Marsden, at the Bay of Islands, in 1815). Although the foreign transferees (not knowing the native custom) often wished others, being co-proprietors, to sign the document of transfer; and this, bye-the-bye, came to be looked upon as the New Zealand custom; whence came the modern belief that *all* must unite in a sale; and thence it followed that one could not sell his own land! But such is not of New Zealand origin.

It will be observed, that there is some difference of opinion between the two writers from whom I have quoted, as to the existence of definite individual rights of property in land, as distinguished from tribal, or common, or indefinite rights; but as this is a point which little concerns the purpose of my narrative, I shall do no more than refer to it here. The extracts above given, at all events sufficiently show that the Maoris always attached the greatest value to the ownership of the soil, and took the utmost care to preserve an accurate knowledge of the boundaries of the tribal estate. The very value, however, attached to the possession of land naturally led to aggression and to the use of various other means of acquiring title to it; and not only in many of their traditions, but also in all other accounts of the habits of the race, we find mention of wars undertaken for purposes of conquest, and of marriage alliances being contracted, and other devices resorted to, for the purpose of peacefully securing additions to the tribal territory. Upon the first of these points, Mr. White tells us that a tribe, in going to war, had one or more of three objects in view:—1. To take revenge for some real or supposed injury. 2. To obtain as many slaves as possible. 3. To extend its territory. "A tribe," he says, "seldom became extinct in consequence of war, but when this resulted, the conquering tribe took all their lands, and from the slaves taken in war the conquerors learnt the boundaries of the land thus taken. But, if a portion of the tribe escaped, their claim held good to as great an extent of land as they had the courage to occupy. If, however, they could manage to keep within their own tribal boundary, and elude their enemy, their right to the whole of the land held good. Hence the meaning of a sentence so often used by old chiefs in their land disputes: *I ko tonu taku ahi i runga i taku whenua* (my fire has been kept burning on my land); meaning that other tribes in war had never been able to drive them entirely off their ancestral claims. The right to lands taken by conquest rests solely on the conquering party actually

occupying the taken district, to the utter exclusion of its original owners or other tribes; thus, in a war of the celebrated Hongi, he drove all the tribes out of the Auckland district into Waikato, and even as far as Taranaki; but though the whole district thereby became his, yet, as he did not occupy it, the conquered tribes, on his return to the North, came back to their own lands; and we found them in occupation when Auckland was established as an English settlement. Again, in the case of a tribe which had been conquered and had become extinct, with the exception of those who had been made slaves by the conquering party, these slaves could, by purchase, recover the ownership of their tribal rights to land, or they could be liberated and return to their own lands on a promise of allegiance to the conquerors, rendering them any assistance, if required, in times of war, and supplying them, for the first few years after their return, with a certain amount of rats, fish, and fern-root; and eventually, on presenting the conquerors with a greenstone battle-axe (the *mere pounamu*), they were again allowed to be called a tribe, and claim the lands of their fathers as though they had never been conquered.

The claims in connection with lands given to a tribe for assistance rendered in war are more complicated than any other. Although the land was given to the leader of the tribe rendering such assistance, it did not thereby become vested in that individual leader, inasmuch as the assisting tribe were seldom alone, but had brought their allies, and, if these allies had lost any of their chiefs in battle, each relative of the deceased chiefs had a claim in the land thus given; and each relative of any chief who had been killed, of the tribe to whose leader the land was given, had also a claim. But the complication of land claims does not end even here. It was necessary that the land given should be occupied so that possession of it be retained, and as the assisted and assisting tribes became related by intermarriage, the tribal lands of the assisted tribe were claimed by the issue of these marriages, according to the laws relating to the ownership of land as affected by the marriage tie, so that after a few generations their respective claims not unfrequently became the cause of another war. An instance of this happened about four generations ago. One of the northern tribes rendered assistance in time of war to a southern tribe, now residing not far from Auckland, and a portion of land was given to the northern tribe; shortly afterwards the daughter of the southern chief was taken in marriage by one of the chiefs of the northern tribe; the two sisters of this woman were married to chiefs of the southern tribe, and thereupon their children's claims held good; but when the time came for the offspring of the sister, who had married the northern chief, to give up their land, the colonization of New Zealand had commenced, and land became a marketable commodity. This offspring retained their claims against all right and argument, and to this day there is a rankling feeling between the tribes concerned;

and if, in this disputed land, incautious dealing by Europeans takes place, it would probably result in a Maori war. The war in the Bay of Plenty, which has been continued until very lately between certain chiefs, also originated in a like cause; the contending parties were all of one tribe, and sprung from one ancestor, but, by intermarriage, some have a more direct claim than others. The descendants, who, by intermarriage, are related to other tribes, have made an equal claim to the land over which they have but a partial claim, and resistance to this was the cause of the war. Disputes of this kind are not easily unravelled. I believe that were it possible to teach the Maoris the English language, and then bring them into some Court, allowing each contending party to plead his cause in such a dispute as I have mentioned, not according to English law, but according to Maori custom, both sides would, according to native genealogy and laws, make out their respective cases so clearly that it would take a judge and jury, possessed of more than human attainments, to decide the ownership of the land.

While speaking about lands claimed by conquest, I will give a few instances of land claimed by the offspring of those male or female chiefs who have been made slaves in war. It would not generally be supposed that lands disposed of at the southern end of this Island would affect any native at the northern end of it, yet such is the case. A chieftainess who was taken slave from the South by the Ngapuhi and other northern tribes, became the wife of a Ngapuhi chief; her claim stood in the way of completing a sale of the land, and it was not until the consent of her son by the Ngapuhi chief was gained, that the land could be disposed of by the natives residing on it, and to him, in due course of time, a portion of the payment was transmitted. Again, a chief who was taken slave from the Bay of Plenty by the northern tribes, having taken a northern woman to wife, and having a family, his relatives from the Bay of Plenty made presents to the chiefs by whom he was taken, and procured his return home; but he was obliged, according to Maori laws of title to land, to leave his wife and daughters with the Ngapuhi people, for if he had taken them with him, they would have lost their claim to land at Ngapuhi, and would not be allowed any claim to land in the Bay of Plenty; while his son, whom he took back with him, now claims, by right of his grandfather, an equal right to the lands of the Bay of Plenty tribe. Again, one of the northern chiefs having taken to wife a woman whom he had made slave from Taranaki, and having a son by her, this son returned to the tribe of his mother and claimed as his right, derived from his grandfather, a share in their land, which was not disputed, because, as I have before stated, the great-grandchild in the female line has a claim to land. I remember another instance of this: a certain block of land was sold by a tribe near Auckland, and when the purchase money was portioned out amongst the claimants, a

northern chief rose up and rehearsed his genealogy, by which he proved that he was the great-grandchild (in the female line) of one of the claimants of the block sold. He thereupon, as a matter of course, received a part of the purchase money. He was a northern chief, aud had only been known to the settlers by name."

In addition to the above points, which more especially affect the events of my narrative, Mr. White gives us details of other modes of acquiring title to land, with illustrative cases of the most interesting kind; but there is one custom which he does not refer to, and which was mentioned to me by Wi Tako Ngatata, namely, that in some cases a conquered tribe, absolutely driven from its lands, was formally restored to possession by the conquerors. He stated, as an instance, that this was done in the Wairarapa, after the Ngatikahungunu had been forced to the northward by the Ngatiawa, under E Puni and himself, in revenge for some isolated acts of violence perpetrated upon members of their own tribe. He informed me that this proceeding was always a highly formal and ceremonious one, and was carried out, in the instance in question, in consequence of many intermarriages having taken place between the two tribes since the settlement of the Ngatiawa near Port Nicholson, and of the absence of any desire on the part of the latter to push their vengeance to extremity. It would lead me too far, were I to enter more at length upon the points above referred to, and I will now proceed shortly to notice some of the leading features in the character and habits of the natives in other respects. There can be little doubt that, both in intellectual and physical capacity, the Maori occupies a high position amongst savage people; but I cannot agree with Mr. White when he says, "that in dealing with him, we deal with a man of powerful intellect." I admit that he possesses much intelligence, and a quick perception, but he is wanting in one of the chiefest characteristics of the civilized man—a characteristic only acquired by a long course of national education—namely, the power of foreseeing the result of these special classes of actions to which his contact with Europeans gives the greatest importance. It is not, however, altogether in this respect that I propose to view his character, for the principal events in my narrative took place before the colonization of the Islands; and their want of foresight when dealing with the agents of the New Zealand Company would not have produced effects injurious to them, but for the occurrence of events which have taken place since the death of Te Rauparaha. "Their ordinary course of life," says Mr. Manning, speaking of the natives, "when not engaged in warfare, was regular, and not necessarily unhealthy; their labour, though constant in one shape or other, and compelled by necessity, was not too heavy. In the morning, but not early, they descended from the hill pa to the cultivations in the low grounds; they went in a body, armed like men going to

battle, the spear or club in one hand, and the agricultural instrument in the other. The women followed. Long before night (it was counted unlucky to work till dark) they returned to the hill in a reversed order; the women, slaves, and lads, bearing fuel and water for the night, in front; these also bore, probably, heavy loads of kumera or other provisions. In the time of year when the crops, being planted and growing, did not call for their attention, the whole tribe would remove to some fortified hill, at the side of some river, or on the coast, where they would pass months in fishing and making nets, clubs, spears, and implements of various descriptions; the women, in all spare times, making mats for clothing, or baskets to carry the crop of kumera in, when fit to dig. There was very little idleness, and to be called "lazy" was a great reproach. It is to be observed, that for several months the crops could be left thus unguarded with perfect safety, for the Maori, as a general rule, never destroyed growing crops, or attacked their owners in a regular manner until the crops were nearly at full perfection, so that they might afford subsistence to the invaders; and, consequently, the end of the summer all over the country was a time of universal preparation for battle, either offensive or defensive, the crops being then near maturity." This picture exhibits a very unhappy condition of existence, for it is manifest that no race, in such a position, could ever rise further in the scale of civilization (paradoxical as the language may appear) than was sufficient to improve their knowledge of the art of war. But, notwithstanding this unsatisfactory condition of the tribes, the people appear, in their social and domestic relations, to have been, generally speaking, good natured and hospitable, though being little, if at all, fettered by conscientious motives or restraints, they were at all times easily roused to acts of violence and cruelty. With them, moreover, revenge was a most persistent feeling, and the duty of ministering to it was considered of sacred obligation. Their love of war was universal and intense, and in its prosecution they were as reckless of the consequences to themselves as they were of the results to their foes. "Nothing," says Mr. Manning, "was considered so valuable or respectable as strength and courage; and to acquire property by war and plunder was more honourable, and also more desirable, than by labour." Their cruelty to their prisoners was frightful. Cannibalism was considered glorious, and this habit led not only to the most dreadful atrocities, but also to a degree of callousness, in regard to the sufferings inflicted upon others, which appears to be utterly incompatible with, and renders singularly remarkable, the kindliness of feeling which they constantly exhibited in their domestic relations. It is clear, however, that whatever good qualities the Maori possessed in his quiet and social moments were utterly lost when he was acting under the impulse of passion. Mr. Colenso, in describing their character, particularly alludes to their love for children,

and remarks that "nothing more clearly shows the truth of the old adage, 'the best corrupted is the very worst,' than that a party of New Zealanders should be so carried away by the diabolical frenzy of the moment as wholly to forget their strongly and highly characteristic natural feelings, and kill, roast, and eat little children." I need not, however, dwell any further on the subjects specially treated in this chapter, for their habits and customs must necessarily come, more or less, under further consideration throughout the course of my narrative.

Chapter II.

Before noticing the condition of the New Zealand tribes during the twenty years immediately preceding the systematic colonization of the islands, I think it necessary to call attention to the accounts we have received, both from early voyagers and from late writers of authority, as to the extent of the native population, and their habits of life, previously to the introduction of fire-arms; and I do this chiefly for the purpose of showing, that notwithstanding the savage character of the former wars of the New Zealanders, the effects which those wars produced upon their numbers were as naught when compared with the destruction of life, both direct and indirect, which followed upon the use of the more deadly weapon of the civilized man. The earliest notice we have of the present race, occurs in the history of the voyage of Abel Tasman to the South Seas, in the seventeenth century, from which we learn that, in December, 1642, he discovered a high mountainous country, which he named Staaten Land, or Land of the States, but which is now called New Zealand. A day or two afterwards, he anchored in the beautiful bay at the north-western extremity of the Nelson Province, formerly named Massacre, or Murderer's Bay, on account of the murder to which I am about to refer, but which is now known, on the maps of the Nelson Province, as Golden Bay. He says that he there found abundance of inhabitants, whom he describes as very large made people, of a colour between brown and yellow, with hoarse voices, and with hair long, and almost as thick as that of the Japanese, combed up and fixed on the top of their heads with a quill or some such thing, that was thickest in the middle, in the very same manner the Japanese fastened their hair behind their heads. Some of them covered the middle of their bodies with a kind of mat, and others with what Tasman took to be a sort of woollen cloth; but their upper and lower parts were altogether naked. Tasman remained in the bay for several days, and on the 19th of December the savages, who had previously been shy of close intercourse, grew bolder and more familiar, insomuch that they at last ventured on board the "Heemskirk" (one of his ships) to trade. As soon as he observed this, he sent his shallop, with seven men in it, to put the people in the

"Heemskirk" on their guard, and to direct them not to place too much trust upon the good intentions of their visitors. The men in the shallop were at once attacked by the savages, and, being without arms, three of them were killed, the remaining four fortunately escaping by rowing for their lives. Tasman intended to have taken revenge for this murderous assault, but was compelled to leave without doing so, in consequence of rough weather coming on. It is probable that the people, by whom his boat's crew was attacked, belonged either to the Ngaitahu tribe—who, under the leadership of their ancestor Tahu, a chief of the Ngatikahungunu, crossed Cook Straits nearly three hundred years ago—or to the Rangitane and Ngatiapa, large numbers of whom also crossed Cook Straits some time before Tasman's visit, and took part in the destruction of the Ngatimamoe and other tribes which had previously occupied the northern parts of the Middle Island; but I am unable to determine this point. It is clear, however, that the number of natives then living in Massacre Bay was large, and that they exhibited the same fearless and ferocious character which led to such frequent hostile collisions with them, during the visits of subsequent voyagers. Our next accounts are derived from our own navigator, Cook, who had been directed to follow out the discoveries of Tasman regarding New Zealand and Van Dieman's Land, in order to ascertain whether they constituted part of the then little known continent of Australia. In October 1769, Cook first made land at a place which he named Poverty Bay. He did not then know that he had fallen in with the Staaten Land of Tasman, and the country he had found formed the subject of much eager discussion amongst the voyagers, the general opinion inclining to the belief, that it was part of the continent of Australia. He described the country in the neighbourhood of his land fall as being thickly peopled, and was greatly struck with the appearance of a pa, the use of which he was unable at the time to conceive. "Upon a small peninsula, at the north-east head of the bay, we could plainly see," he says, "a pretty high and regular paling, which enclosed the whole top of the hill, which was the subject of much speculation, some supposing it to be a park for deer, others an enclosure for oxen and sheep." Of course, Cook soon afterwards discovered the nature of these structures, which will be fully referred to in the sequel, and which had nothing to do either with deer, oxen, or sheep. Having landed for the purpose of watering the ship, his people were at once attacked with spears and "a sort of war hatchet of green slate, capable of splitting the hardest skull at a blow." Notwithstanding all his efforts to conciliate, he found it impossible to come to any amicable understanding with the natives, even though Tupia (his interpreter) assured them that no harm was intended; and his seamen at last only effected their retreat in safety, after killing one of their assailants. The next day he again endeavoured to open friendly intercourse

with the natives, and succeeded in approaching them, but they then became as thievish as they had previously proved daring. They endeavoured to snatch the arms out of the men's hands, and were only prevented from doing so by some of them being wounded with small shot.

Failing in his attempts to communicate satisfactorily with them on land, Cook now endeavoured to secure some of those who came out to the ship in their canoes, intending to try and win their confidence by kind treatment. In carrying out this design, four more of the natives were killed, but two lads were captured and carried aboard, where they soon became reconciled to their fate, and eat and drank voraciously. These lads were afterwards landed, but the people still remained as hostile and dangerous as before. Cook then followed the coast, northward, as far as Hawke's Bay, everywhere observing vast numbers of people watching the ship from different parts of the shore, all of whom, however, displayed the same hostility, coming off in their canoes, and menacing the ship "with great bravado." When some of them came near enough, Tupia told them of their folly, explaining "that the white men had weapons that, like thunder, would kill them in a moment, and tear their canoes to atoms." In order to show them the effect of the guns, without hurting them, a four-pounder, loaded with grape, was fired, which by its flash, its roar, and the effect of the shot far off on the water, astonished them for a moment; but only for a moment. Being at last induced to come near, for barter, they took everything offered, but then refused to give the articles required in exchange, and ultimately seized and attempted to carry off Tayeto, Tupia's boy, who had been sent down into one of the canoes, in order to hand up such articles as the natives might agree to part with. This compelled Cook to fire on them again, when one man was killed, and two others were wounded, and the boy, during the surprise, sprang into the water; where, however, he was only protected till he regained the ship, by the firearms of the crew. This occurred at Kidnappers' Point, and Cook then proceeded southward as far as Cape Turnagain; from whence he returned to the north-eastward. On passing Portland Island, a chief and four others, in a canoe, boarded the ship—Cook's kindness to the lads whom he had previously seized having, apparently, produced the effect he intended. Their canoe was hoisted on board, and they stayed all night without any misgivings. In the morning they were put ashore at Cape Table, appearing to be much astonished at finding themselves so far away from home. From this time the ship was frequently visited, and it was found that the events which had taken place at Poverty Bay were well known all along the coast. According to Cook, "kindness and the cannon" both contributed to produce this more friendly feeling.

At Tolega Bay, some of the scientific men attached to the expedition

landed for the first time, taking Tupia and Tayeto with them. Here they had their first close view of the houses and mode of life of the people. They entered some of the huts, and saw them at their meals. These huts are described as being very slight, and generally placed ten or fifteen together.

The chief food appeared to be fish and fern-root, the fibres of which were spit out, like quids of tobacco, into baskets set beside them for the purpose. This was in October, and Cook learnt that, in the more advanced season, the natives had plenty of excellent vegetables, but no animals except dogs, which they ate like the South Sea Islanders. They visited the native gardens, which consisted of from one acre to ten, and altogether, in the bay, amounted to 150 or 200 acres in extent. These gardens are described as being planted with sweet potatoes, coccos or eddas (such as are used in the East and West Indies), yams, and gourds; but few of them were then above ground, and the plantations were carefully fenced in with reeds. They found both men and women painted with red ochre and oil, but the women much the most so; and that, like the South Sea Islanders, they saluted by touching noses. They wore garments of native cloth, made from the fibre of New Zealand flax, and a sort of cloak or mantle of a much coarser kind. The women are described as being more modest in manner, and more cleanly in their homes, than the Otaheiteans. They willingly bartered their cloth and war weapons for European cloth, but they set no value on nails, having then no knowledge of iron or its uses. What astonished the visitors greatly was to find boys whipping tops exactly like those of Europe. Cook then visited a pa, and learned that these enclosures were used for purposes of defence against invasion, the houses, within the enclosure, being larger and more strongly built than those on the shore. He describes the men as having their faces wonderfully tattoed, and their cheeks cut in spiral lines of great regularity; and states that many of them had their garments bordered with strips of dog and rat skins, which animals, however, were said to have become very scarce. They measured one canoe, made out of the boles of three trees, which was sixty-eight and a half feet long, five wide, and three high. These, as well as the houses, were much adorned with carvings, in which spiral lines and distorted faces formed the main points, but the work was so well done, that Cook could scarcely believe that it was executed with any of the tools he saw.

He then followed the south-east coast as far as Mercury Bay, and from thence to the Bay of Islands, everywhere observing villages full of people, who constantly came off in their canoes to utter defiance to the ship, displaying, on all occasions, the same reckless daring and unreflecting courage, which were so conspicuous during the late war. It was surprising, indeed, that half-a-dozen naked men, in a crazy canoe, should defy a large ship with all its cannon and musketry, even after they had seen its destructive effects. Sometimes they

assumed a more friendly aspect, and began to trade; but as soon as they had obtained what they wanted, they refused to give up the equivalent, and laughed at all menace of consequences, till they suffered wounds or death as a punishment, and then the survivors paddled off for a time. These accounts are confirmed, in all particulars, by other voyagers who visited New Zealand during the latter part of the last, and the earlier part of the present century, and lead to the conclusion that, prior to the year 1818, the native population was very large; and although we know, as I have before observed, that neighbouring tribes had been for ages constantly engaged in war with one another, it would also seem that the general results of their conflicts had not, until after the introduction of fire-arms, been such as materially to interfere with the maintenance of their numbers.

Mr. Manning, one of the judges of the Native Lands Court, a gentleman whose opportunities of acquiring knowledge on this subject have been unrivalled, also bears testimony to the former large numbers of the native people. "The natives," he says, "are unanimous in affirming that they were much more numerous in former times than they are now, and I am convinced that such was the case for many reasons." In support of this opinion, he refers to the existence, in most parts of the North Island, of numerous hill-forts or pas, many of them so large as to have required immense labour to trench, terrace, and fence. As he points out, the absence of iron tools must have greatly increased the difficulty of constructing these fortresses; whilst, even with the aid of such tools, the present population of the surrounding districts would, in most cases, be insufficient to erect them within any reasonable time. He also mentions that many of these forts were of such an extent that, taking into consideration the system of attack and defence necessarily used before the introduction of fire-arms, they would have been utterly untenable, unless held by at least ten times the number of men which the whole neighbourhood, for a distance of two or three days' journey, can now produce; and as, in those times of constant war, the natives, as a rule, slept in their hill-forts with closed gates, the bridges over the trenches removed, and the ladders of the terraces drawn up, it is evident that the inhabitants of each fort, though numerous, consisted only of the population of the country in its close vicinity.

"From the top of one of these pointed, trenched, and terraced hills," says Mr. Manning, "I have counted twenty others, all of equally large dimensions, and all within a distance, in every direction, of fifteen to twenty miles; and native tradition affirms, that each of these hills was the stronghold of a separate *hapu*, or clan, bearing its distinctive name." We have, moreover, evidence that vast tracts of land which are now wild, and have been so for time out of mind, were once fully and carefully cultivated. The ditches for

draining are still traceable, and hundreds of large kumera pits are to be seen on the tops of the dry hills all over the northern part of the North Island.

These pits, in the greatest number, are found in the centre of extensive tracts of uncultivated country, whose natural productions would now scarcely sustain a dozen inhabitants. The extent of the ancient cultivations with which they are connected is clearly traceable, and what is more remarkable, and undoubtedly indicates the former existence of a large population, is that tracts of land of what the natives consider, as a rule, to be of very inferior quality, were formerly cultivated, leading to the inference either that the population was fully proportioned to the extent of available land, or that these inferior lands were cultivated in consequence of their vicinity to some stronghold, or position of greater consequence, in the eyes of the natives, than the mere fertility of the surrounding country. "These kumera pits," says Mr. Manning, "being dug generally in the stiff clay on the hill-tops have, in most cases, retained their shape perfectly, and many seem as fresh and new as if they had been dug but a few years. They are oblong in shape, with the sides regularly sloped. Many collections of these provision stores have outlived Maori tradition, and the natives can only conjecture to whom they belonged. Out of the centre of one, which I have seen, there is now growing a kauri tree, one hundred and twenty feet high, and out of another a large totara. The outline of these pits is as regular as the day they were dug, and the sides have not fallen in in the slightest degree; from which, perhaps, they have been preserved by the absence of frost, as well as by a beautiful coating of moss, by which they are everywhere covered. The pit in which the kauri grew had been partially filled up by the scaling off of the bark of the tree, which, falling in patches, as it is constantly doing, had raised a mound of decaying bark round the root of the tree."

Mr. Manning points out, as further evidence of the former existence of a large population, that each of the hill-forts referred to contained a considerable number of houses. Every native house, as we know, has a fire-place composed of four flattish stones or flags, sunk on their edges into the ground, in which a fire is made to heat the house at night. Now, in two of the largest hill-forts he examined (though for ages no other vestige of a house had been seen) there remained the fire-places—the four stones projecting, like an oblong box, slightly above the ground; and their position and number clearly denoted that, large as was the circumference of the huge volcanic hill which formed the site of the fortress, the number of families inhabiting it, required the strictest economy of room. The houses had been arranged in streets, or double rows, with paths between them, except in places where there had been only room, on a terrace, for a single row. The distances between the fire-places proved that the houses in the rows must have been as close together as it was possible to build them;

and every spot, from the foot to the hill-top, not required, and specially planned for defensive purposes, had been built on in this regular manner. Even the small flat top, sixty yards long by forty wide—the citadel—on which the greatest care and labour had been bestowed to render it difficult of access, had been as full of houses as it could hold, leaving only a small space all round the precipitous bank for the defenders to stand on.

It would not be difficult to multiply authorities, in order to prove that the New Zealanders were formerly much more numerous than when the Islands were first systematically colonized by Europeans, but I conceive that I have afforded sufficient evidence on this point, and it now remains for me to notice the principal causes which led to their decrease.

"The natives," says Mr. Manning, "attribute their decrease in numbers, before the arrival of the Europeans, to war and sickness;" but I have already shown, that although the weapons they used before they obtained firearms were sufficiently formidable in close combat, the destruction of life incident to the possession of such weapons would, probably, never have brought about the deplorable results which followed upon the introduction of the musket into their system of warfare. Indeed, Mr. Manning himself leans to this opinion. "The first grand cause," he says, "of the decrease of the natives, since the arrival of the Europeans, is the musket." Now, it was not until after the year 1820 that fire-arms were extensively used in native warfare. Shortly before that date, the Ngapuhi chiefs, Hongi and Waikato, had visited England, from whence they returned laden with valuable gifts, of which no small part consisted of guns and ammunition, for which, too, they soon bartered the remainder of their newly-acquired treasures, with traders from New South Wales.

Then commenced a period of slaughter almost unparalleled in any country, when compared with the total population engaged in the conflicts. Bands of the Ngapuhi, armed with weapons whose destructive power was unknown to the great majority of the native people, marched from one end of the North Island to the other, carrying dismay and destruction wherever they went. The population of large districts was exterminated or driven into mountain fastnesses, where they either perished, in numbers, from famine and exposure, or contracted diseases which ultimately proved fatal to them. The great tribes of the Arawa and Waikato, against whom the first efforts of the Ngapuhi were directed, seeing the necessity of at once obtaining similar weapons, in order to avoid threatened destruction, suspended all their usual pursuits for the purpose of preparing flax, to be exchanged with the European traders for guns, powder, and ball. As fast as these were obtained, they were turned against weaker neighbours, and the work of destruction received a fresh impulse. Hongi, Epihai, Tamati Waka Nene, and Tareha, amongst

the Ngapuhi chiefs,—Te Wherowhero, and others of the Waikatos,—and Te Waharoa, with his Ngatihaua, were all simultaneously engaged in the most ruthless wars against their neighbours; whilst, as I have before observed, Te Rauparaha was carrying on operations of a similar character in the South, and the number of people slaughtered was tremendous. On this head, I might quote many graphic passages from Mr. J. A. Wilson's "Story of Te Waharoa." In speaking of the ultimate destruction of the great pa at Matamata, he tells us, "That at that time a number of Ngatimaru, with Tuhurua as their chief, resided at Matamata, an important fortress, not far from Mangakawa, Te Waharoa's own place, and therefore in a position which rendered them specially open to his incursions. Nor could they expect any effective aid against these incursions from the other sections of the tribe, whose internal jealousies, and constant dread of the Ngapuhi, then using their newly acquired weapons, in taking vengeance for former injuries, prevented them joining Ngatimaru proper against the common enemy. But for these circumstances, of which Te Waharoa was, no doubt, well aware, it is considered questionable whether he would have succeeded in his designs, as the Thames natives, before they lost the Totara Pa, mustered 4,000 fighting men; and, even after that disaster, he was unable, by mere strength, to wrest it from its possessors." The following events, however, determined him to prosecute his war with Ngatimaru, and greatly contributed to his ultimate success.

"In 1821," says Mr. Wilson, "a *taua* of Ngapuhi, under the celebrated Hongi, arrived at the Totara Pa, between Kauaeranga and Kopu, at the mouth of the Thames. So numerous did they find Ngatimaru, and the Totara so strong, that, hesitating to attack, they affected to be amicably disposed, and were received into the pa for the purposes of trade and barter. Towards evening Ngapuhi retired, and it is very remarkable—as indicating that man, in his most ignorant and savage state, is not unvisited by compunctions of conscience—that an old chief of the Ngapuhi lingered, and going out of the gate behind his comrades, dropped the friendly caution '*kia tupato.*' That night, however, the Totara was taken; and, it is said, 1,000 Ngatimarus perished. Rauroha was slain, and Urimahia, his daughter, was carried captive to the Bay of Islands, where she remained several years. This calamity, while it weakened Ngatimaru, encouraged Te Waharoa.

In 1822, Hongi again appeared, and sailing up the Tamaki, attacked and carried two pas which were situated together, on part of the site now occupied by the village of Panmure. Many of the inhabitants were slaughtered, and some escaped. I would here observe that these two pas, Mauinena and Makoia, had no connection with the immense pa which evidently at some time flourished on Mount Wellington, and which, with the traces of a very

great number of other enormous pas in the Auckland district, betokens the extremely dense Maori population which once existed upon this isthmus—a population destroyed by the late owners of the soil, and numbered with the past; but which, in its time, was known by the significant title of Nga Iwi—'The Tribes.'

Leaving naught at Mauinena and Makoia but the inhabitants' bones, having flesh and tendons adhering, which even his dogs had not required, Hongi pursued his course. He drew his canoes across the isthmuses of Otahuhu and Waiuku, and descended the Awaroa. At a sharp bend in the narrow stream, his largest canoe could not be turned, and he was compelled to make a passage for her, by cutting a short canal, which may yet be seen.

At length he arrived at Matakitaki, a pa situated about the site of the present township of Alexandra, where a number of Waikato natives had taken refuge. The pa was assaulted, and while Hongi was in the act of carrying it on one side, a frightful catastrophe was securing to him the corpses of its wretched occupants on the other. Panic-stricken at the approach of the victorious Ngapuhi, the multitude within, of men, women, and children, rushed madly over the opposite rampart. The first fugitives, unable to scale the counterscarp, by reason of its height, and of the numbers which poured down on them, succumbed and fell; those who had crushed them were crushed in like manner; layer upon layer of suffocating humanity succeeded each other. In vain did the unhappy beings, as they reached the parapet, attempt to pause—death was in front, and death behind—fresh fugitives pushed on; they had no option, but were precipitated into, and became part of the dying mass. When the deed was complete, the Ngapuhi came quickly up, and shot such as were at the surface and likely to escape.

Never had cannibals gloated over such unexpected good fortune, for more than 1,000 victims lay dead in the trench, and the magnitude of the feast which followed may, perhaps, be imagined from the fact that, after the lapse of forty-two years, when the 2nd Regiment of Waikato Militia, in establishing their new settlement, cleared the fern from the ground, the vestiges of many hundred native ovens were discovered, some of them long enough to have admitted a body entire; while numberless human bones lay scattered around. From several of the larger bones, pieces appeared to have been carefully cut, for the purpose, doubtless, of making fish-hooks, and such other small articles as the Maoris were accustomed to carve from the bones of their enemies."

Nor was Te Waharoa idle during all this time. Having, by his courage, activity, and address, acquired the leadership of his own people, he had long determined to extend the boundaries of their territory by conquering that of the Ngatimaru; but, before commencing his sanguinary wars against that tribe, he had felt it necessary to form offensive and defensive alliances with the

Ngatimaniapoto and to check Te Wherowhero and the Waikatos, by whom he had been threatened, but into whom he succeeded in inspiring a wholesome dread of his strength, whilst he also repelled, with heavy loss, the incursions of the Ngapuhi, which were directed indiscriminately against all the tribes south of the Auckland Isthmus. He succeeded, moreover, in causing Te Rauparaha, as pugnacious and skilful a warrior as himself, to leave Kawia with his people. He then pressed his alliance upon the Ngaiterangi, who occupied Tauranga and the surrounding country, an alliance, which, by the way, proved very disastrous to them, whilst it greatly aided his own projects. Having done all this he commenced his more regular operations against the Ngatimaru, who were then established in great strength at Hauwhenua, where they had been joined by the refugees from Mauinena and Makoia. He had naturally viewed the establishment of this stronghold with the utmost jealousy, and it had no little effect in hastening the commencement of hostilities between the two parties. Feeling that his own warriors were not sufficiently numerous to attack the hostile pa, he summoned some of his Waikato and Ngatimaniapoto allies to Maungatautari, who, only too ready, at once joined him to the number of 200 warriors. His own force comprised some 700 Ngatihaua and Ngaiterangi.

In the meantime, the Ngatimaru had spared no pains to strengthen their important stronghold, their garrison having, moreover, been increased by numbers of Ngatitematera and Ngatipaoa. The pa thus became a very large one, and densely peopled, not only with warriors, but with women, children, and slaves. Their numbers appear to have inspired them with much self-confidence, for when it became known that Te Waharoa had arrived at Maungatautari, with a *taua* 900 strong, they boldly determined to meet him in the open field. Perhaps they wished to decide the matter before he could receive further reinforcements ; or perhaps they desired to avoid the mortification of seeing the enemy sit comfortably down before their pa, and regale himself on their cultivations. At any rate, they marched forth and took post on the hill, Te Tihi o te Ihimarangi—the place where the descendants of Waharoa's warriors opposed General Cameron in 1864 ; and, when the enemy was seen to approach, they rushed down and joined battle with him on the plain to the eastward. The contest was a severe one, but resulted in the complete defeat of the Thames natives. They were driven back over Te Tihi o te Ihimarangi, and down its reverse slope, and were pursued, with great slaughter, over the long narrow bushy plain that extends to Hauwhenua. At the end of a long and sanguinary day, the dejected men within the pa sat dreading the morrow's light, whilst Te Waharoa calmly considered his own and his enemy's positions. After resolving the matter for some time, he sent a herald to proclaim to the occupants of the pa "that during the next four

days anyone might retire unmolested from the pa, but on the fifth day Hauwhenua, with all it contained, would be taken and destroyed." No answer was returned, but during the interval a multitude of all ages and sexes issued forth from the pa, and marched in close order along the road by Matamata to the Thames. That night Te Waharoa's ranks were recruited by many slaves, who deserted, under cover of darkness, from the retreating Ngatimarus, and on the following day the pa was assaulted and taken. The fall of Hauwhenua, which occurred about 1831, terminated the residence of the Ngatimaru on the Waikato; and was followed by operations, from a Waikato basis, which were successfully conducted against them, on the line of the Piako.

Whilst the earlier of these events were proceeding, the Ngatimaru chief, Takurua, maintained his position at Matamata; but about that time he appears, after much fighting, to have judged it advisable to accept terms of peace proposed by Te Waharoa. They were to bury the past in oblivion, and both parties were to live at Matamata, where, it was said, there was room for all. These terms were practically ratified by Te Waharoa and Takurua living side by side, in the utmost apparent friendship, for a period of about two years. Waharoa then, however, committed an act of perfidy, condemned even by the opaquely-minded savages of that day, by which he obtained sole possession of Matamata, and so turned the balance of power in his own favour, as greatly to aid him in his ultimate designs. One afternoon he left Matamata on pretence of a necessary journey to Tauranga—a circumstance rather calculated to lull suspicion than otherwise—and during his absence, his tribe at midnight rose, and massacred, in cold blood, the too confiding Takurua, and nearly every man of his tribe. Their bodies were devoured, and their wives and property were shared by the ruthless Ngatihauas.

This Maori St. Bartholomew's day occurred about 1827, and so weakened Ngatimaru, that Te Waharoa was enabled, after the fall of Hauwhenua, to push his conquests to the foot of the Aroha, and it is difficult to say where they would have ceased, had not his attention been unexpectedly diverted by the casual murder of his cousin Hunga, at Rotorua, in the latter end of the year 1835."

I make no apology for citing these instances of atrocity, which exhibit, in the strongest light, the dreadful character of the wars carried on by the great chieftains in the North, during the twenty years succeeding Hongi's return from Europe. Indeed, this period has been well characterized by Mr. Colenso "as a fearful period in New Zealand." "The Ngapuhi," he says, "being well armed with muskets, revelled in destruction, slaying thousands. At Kaipara, Manukau, Tamaki, the Thames, the interior of Waikato on to Rotorua, and

even to Taranaki; and they also came in their canoes as far South as Ahuriri or Hawke's Bay, remorselessly destroying everywhere as they went. The tribes further North were also fighting against each other—the Rarawa destroying the Aopuri, who were very numerous about the North Cape. Te Wherowhero, at the head of his people, was slaughtering, for many years, on the West Coast, from Taranaki to Wanganui; Te Waharoa, and other chiefs, in the interior and overland to Hawke's Bay; the Rotorua tribes in the Bay of Plenty; and Te Rauparaha exterminating in the neighbourhood of Cook Straits and along the East Coast of the Middle Island. From 1822 to 1837 was truly a fearful period in New Zealand. Blood flowed like water, and there can be no doubt that the numbers killed during this period of twenty years, including those who perished in consequence of the wars, far exceeded 60,000 persons."

The preliminary sketch contained in the foregoing chapters, though brief, will, I hope, convey to my readers a sufficiently clear idea of the manners and customs, and character of the New Zealanders, and of the condition of the tribes previously to the systematic colonization of the Islands, and will, be found to aid them materially in understanding the events which will be detailed in the following pages. It shows, moreover, the frightful results brought about by placing the deadly weapons of European warfare, in the hands of a savage and warlike race, whilst still uncontrolled by those milder influences, to which, notwithstanding their ferocity, the New Zealanders have shown themselves so singularly open and amenable.

Chapter III.

At the time of the birth of Te Rauparaha, and, indeed, for many generations before that event, the Ngatitoa tribe occupied the country lying between Kawhia and Mokau on the western side of the North Island, and extending backward, from the coast line, to the seaward slopes of the beautiful Pirongia mountain, and of the chain of hills to the southward, which bounds the valleys of the Waipa and the Mangarama. This tribe, in fact, claims to have held the country in question ever since its settlement by their ancestor, Hoturoa, a leading chief amongst those who are said to have come from Hawaiki in the "Tainui" canoe. It will be remembered that this canoe was dragged across the portage at Otahuhu after the disputes between Tama Te Kapu and Manaia about the dead whale, its chiefs and their followers settling in and around Kawhia, and their descendants gradually spreading to the eastward as far as Maungatautari. The Maoris, in various parts of the Islands, believe that several of the canoes in which their ancestors came from Hawaiki have been transformed into stone, and a remarkable block of limestone, close to the sea-shore, on the north side of the harbour of Kawhia, is

pointed out as being part of the "Tainui." This rock, with the land immediately surrounding it, was formerly under strict *tapu*, but the sanctity of the place, and of the supposed relic, have succumbed to the march of civilization, and curiosity-hunters have long since marred the picturesque outline of the stone by breaking off corners. Hoturoa is also said to be the ancestor of the Ngatiraukawa, Ngatikowhata and Ngatimaniapoto tribes, the order of descent in the several cases being much as follows:—From Hoturoa, through Hotumatapu and Kouwe, sprang Raka, whose eldest son, Tuihaua, was the ancestor of Toa Rangatira, the actual founder of the Ngatitoa as a separate tribe, and from whom they derive their name. From another son of Raka, named Kakati, through Tawhao and Turonga, sprang Raukawa, from whom the Ngatiraukawa derive their name. From Toa Rangatira, in direct descent, came Kimihia, the mother of Werawera, who married a Ngatiraukawa woman named Parekowhatu. These two were the parents of Te Rauparaha, and of his sister Waitohi, the mother of Rangihaieta, who will be frequently mentioned in the course of this narrative. Besides Te Rangihaieta, Waitohi had other children, of whom a daughter named Topiora is still living at Otaki, and is the mother of Matene Te Whiwhi, for many years past, and still, one of the most influential chiefs of the Ngatitoa and Ngatiraukawa tribes. Topiora's husband was a Ngatiraukawa man, of high rank, named Te Rangi Kapiki, who himself claimed to be closely connected to Ngatitoa, both by ancient descent and through frequent intermarriages between members of the two tribes. Tracing back again, we find Te Urutira and his sister, Hine Kahukura, in the third place in the ascending line from Toa Rangatira. From Hine Kahukura sprang Parewahawaha and Parekowhatu, the former of whom married Tihau, by whom she had a son named Whatanui, the father of the great chief of that name, who was at the head of the Ngatiraukawa tribe, during the career of Te Rauparaha. We see, therefore, that the leading chiefs of the Ngatitoa and Ngatiraukawa tribes claim descent from common ancestors, and that frequent intermarriages took place between the members of these tribes, since they branched off from the common stock. The same remarks apply, but in less degree, to the descent of the Ngatimaniapoto and Ngatikowhata, who also claim Hoturoa as their remote ancestor; but it is unnecessary, for the purposes of my story, that I should trace up the history of these tribes, as they do not appear to have taken any prominent part in the events in which the Ngatitoa were engaged after their departure from Kawhia.

As my readers are doubtless aware, Kawhia is the only harbour of any note between the Manukau, which lies about sixty miles to the northward of it, and Wanganui, which lies at some distance within the entrance of Cook Straits; but, like all the other harbours on the West Coast of the North

Island, its entrance is somewhat impeded by sand-banks. The entrance is narrow, but inside the Heads the waters spread out for many miles in length and width, having numerous navigable channels leading to a series of small rivers, which flow into the harbour from the eastward. At full tide, this sheet of water is extremely beautiful, surrounded, as it is, with picturesque scenery, which attains its highest effect at the north-east end, in the neighbourhood of the Awaroa River. Rock masses, assuming the forms of towers and castles, occupy its shores, whilst the gullies and valleys of the streams which fall into it contain tracts of fertile and highly cultivated soil. The character of the landscape continues the same far up the slopes of the surrounding mountains, the name of the "Castle Hills" having been given to them in allusion to the masses of white limestone which emerge, in huge castellated forms, from the forest with which these mountains are generally clothed.

Between Kawhia and the Waipa valley, a little to the northward of the former, is the beautiful Pirongia mountain, "an ancient, dilapidated volcano," whose many peaks and ravines afford a grand spectacle when bathed in the mellow light of the setting sun; whilst the soil on its slopes, derived from the decomposition of the trachytic rock of which it is composed, is of the most fertile kind. The climate of the whole district is delightful, the orange and the lemon yielding their fruit with a luxuriance unsurpassed even in the delicious valleys of Granada. The seaward aspect of the mountain chain to which I have alluded, as well as the slopes of the Pirongia, are, however, densely wooded, rendering travelling through this country toilsome and difficult. At the time I speak of, the Ngatimaniapoto occupied the country lying along the coast to the northward, whilst the Waikato tribes, of whom Te Wherowhero was the head chief, claimed the principal part of the valley of the Waipa, and of the country extending to the inner shores of the Manukau. To the eastward, beyond the range shutting in the Waipa valley on that side, and stretching from Otawhao to Maungatautari, lay the possessions of Ngatiraukawa proper, comprising some of the most fertile and beautiful country in the North Island. The Ngatituwharetoa, or Taupo tribes, under the leadership of Tukino Te Heuheu, one of the greatest of the old New Zealand chieftains—a man of gigantic stature and commanding presence, and whose deeds still form the theme of many a wild tale—clustered round the shores of Lake Taupo, and the spurs of Tongariro. As is well known, Te Heuheu met his death by an awful catastrophe in 1846, his village, Te Rapa, having been overwhelmed during the night by a huge land-slip, under which he and his six wives, with upwards of fifty other persons, were buried alive.

I have thought it necessary to mention the tribe of this chief amongst the others above referred to, for although he took a comparatively trifling part in the events in which Te Rauparaha himself was concerned, his friendship and

alliance were of great service to the latter, and permitted a ready means of communication between him and his Ngatiraukawa allies during the prosecution of his designs in the South.

It is almost impossible to determine the date of the birth of Te Rauparaha, but from the best information I have been able to obtain as to his probable age at the time of the Treaty of Waitangi, I am disposed to fix it at about the year 1770. He was born at Kawhia, where, except during occasional visits to other parts of the Island, and especially to his kindred at Maungatautari, he resided until he obtained the complete leadership of his tribe. He had two brothers and two sisters, all older than himself, but his brothers never assumed positions of importance amongst their people, and neither of them ever exhibited the particular qualities which have made Te Rauparaha so famous in the history of "Old New Zealand." Te Rauparaha is said to have been a good, pretty, and playful child, possessing, amongst other qualities, that of obedience in a high degree. It is recorded of him, that on one occasion when directed by an old slave of his father's, named Poutini, to fetch water in a calabash, an order which, considering his rank, he would have been quite justified in disregarding, he at once obeyed and fetched it. But, like other youths, he now and then got into scrapes, and, to use the naif language of his son, "he did many good and many foolish actions." As he advanced in years, his mind developed rapidly, and he soon exhibited an extraordinary degree of wisdom, though his parents scarcely gave him credit for qualities quite apparent to strangers; and, as it seems, were rather inclined to snub him in favour of his elder brothers. But this condition of things did not long continue, and the following incident brought his peculiar talents prominently before his people, and enabled him at once to assume a position of great authority amongst them, leading, ultimately, to the absolute chieftainship of the tribe. It was a custom amongst the Maori chiefs, before the introduction of christianity, to assign a wife to each of their male children, even before the latter had attained the age of puberty. In the case of Te Rauparaha, a girl named Marore had been given to him as the wife of his boyhood, of whom, as he grew up, he became very fond, and in whose cause he obtained his first experience as a warrior—his "baptism of fire." It appears that his parents had invited a large number of the tribe to a feast, and when the food—the fish, the eels, and the kumera—had been placed upon the platform, Te Rauparaha saw that the portion allotted to Marore had no relish. This made him very sad, and after some consideration he asked his father's permission to lead a war party into the country of the Waikatos, in order that some people might be killed as a relish for the food apportioned to Marore. In those days his wish was, no doubt, considered strictly reasonable and proper—strictly *tika* in fact—and his father

at once placed under his leadership a number of young warriors, who were, as we may suppose, perfectly willing to join in such an expedition. During this time, as I have been informed, Te Rauparaha was suffering from some disease, attended with a good deal of physical pain; but notwithstanding this, and against the suggestions of his father to postpone the expedition until his health was better established, he determined to prosecute it, and the war party advanced into the territory of the Waikatos, with whom, at that time, they were in profound peace. In ignorance of their intentions, their advanced parties were permitted to enter a pa of the enemy, who, however, soon discovering their error, flew to arms, and succeeded in driving them out again with some loss. Te Rauparaha, with the remainder of the *taua*, seeing the rout of his advanced guard, at once took cover, unperceived by the Waikatos; and as the latter, in some disorder, were pushing the pursuit, he and his warriors attacked them in flank and rear, and defeated them with much slaughter, at the same time taking many prisoners, amongst whom was Te Haunga, a principal chief, who, with several others, was afterwards killed and eaten "as a relish" to the food apportioned to Marore. The success attending this expedition, and the skill shown by Te Rauparaha in taking advantage of the disorder of the enemy, at once rendered him famous as a Maori warrior; and from thenceforth he occupied a position of influence, not only with his own immediate tribe, but also with those to which it was allied, whilst his growing talents and power were looked upon with much respect and dread by those who had any reason to fear his prowess or his revenge. The event above referred to, naturally led to frequent battles with the Waikatos, in which Ngatitoa, under Te Rauparaha, were generally successful, although occasionally defeated with considerable loss.

In the intervals of peace, Te Rauparaha visited his kindred at Maungatautari, then under the general leadership of Hape Te Tuarangi, a distinguished old warrior, who had fought many battles against the Waikato tribes, and particularly one at Kakamutu, on the Waipa, in which the latter were defeated with tremendous slaughter. On the death of Hape, which will be more specially referred to in the sequel, Te Rauparaha married his chief wife, Akau, who became the mother of Tamihana Te Rauparaha, still living at Otaki, from whom I have obtained a large amount of information respecting the career of his celebrated father. Te Rauparaha, also kept up a constant intercourse with his friends at Rotorua, and frequently visited Te Heuheu, who was much impressed with the character of his visitor, and became his fast and valuable ally. Besides this, he made several excursions to the Thames in order to obtain the alliance of Ngatimaru—then a very powerful people, but who were subsequently nearly annihilated by the Ngapuhi from the North, and by Te Waharoa and his Ngaiterangi allies, as mentioned in the last chapter.

From the chiefs of this tribe, Te Rauparaha obtained a musket, with a quantity of ammunition, gifts of very great value at that time, and indicating the estimation in which he was held by his hosts. He also visited Kaipara, where he soon gained the friendship of the Ngatiwhatua, and other tribes in that district, and on his way back went to the Waitemata—he succeeded in forming an alliance with Kiwi and the son of Tihi, chiefs of the great tribes which then occupied that part of the country. I am led to understand that these visits took place between 1810 and 1815, and that Te Rauparaha then entertained the design of forming an extensive alliance against the Waikatos, under Te Wherowhero, with the intention of completely destroying them ; but he found it impossible to effect his object, and chiefly for the following reason : After the establishment of the convict settlements in Australia, the South Seas were much frequented by whale ships, and the eastern coast of New Zealand, which then afforded a large supply of these valuable animals, became one of the principal whaling grounds. In the course of their voyages the ships often resorted to the Bay of Islands and the Harbour of Whangaroa for supplies of water and vegetables; and during these visits, the natives first learnt the use and power of the musket. The tribes with whom the chief intercourse took place, were the Ngapuhi, who at once saw the immense power which the possession of such a weapon would confer upon them in their contests with their enemies. Previously to this period, their own country had been constantly devastated by the powerful and warlike tribes of the Thames, and they naturally burned for revenge. Singularly enough, they were much aided in their object by the establishment of the mission stations, formed in the year 1813 under the Rev. Mr. Marsden, who had brought down with him, from Australia, pigs and poultry, and many kinds of vegetables, amongst which, the most valuable were the Indian corn and the potato. The pigs were suffered to run wild, and, having increased very much, were usually caught with dogs when wanted for purposes of trade, the natives themselves rarely using them for food, but they eagerly and successfully cultivated all the species of vegetables which had been introduced. Moreover, during the intercourse which took place between them and the whale ships, many natives visited Port Jackson, where they had further opportunities of learning the destructive power of the European weapons, and the eagerness of the tribes to procure them became so great, that twenty hogs, obtained at the expense of enormous labour, and worth to the ships more than as many pounds, were often given in exchange for a musket not worth ten shillings. In effect, the muskets usually sold to these natives were of a very worthless kind, and would not, in a contest with European troops, have been considered particularly dangerous weapons; whilst the natives own want of knowledge of the proper mode of taking care of them, soon led to the greater number of them becoming hopelessly out of

order. But unskilfully as they used the musket, and little as it might have been feared by Europeans, such was the dread of its effects amongst the natives, more especially on the part of the tribes which did not possess them, that the strength of a war party was, at that time, not so much calculated by the number of its members, as by the quantity of fire-locks it could bring into action; and when Paora, a northern chief, invaded the district of Whangaroa in 1819, the terrified people described him as having twelve muskets, whilst the name of Te Korokoro, then a great chief at the Bay of Islands, who was known to possess fifty stand of arms, was heard with terror for upwards of 200 miles beyond his own district.

But the musket was not the only weapon which the natives obtained from the European traders. The bayonet and the tomahawk, the former of which was fixed to a long handle, began to replace in their fights the wooden spear and battle-axe, and naturally added greatly to the offensive power of those who possessed them in any numbers. As fast as the Ngapuhi acquired these arms, they made hostile expeditions against the Ngatimaru, and other tribes occupying the Thames, and the shores of the Tamaki and Waitemata, carrying terror and destruction wherever they went. But in proportion as the whale ships and traders from Sydney extended their intercourse with the natives, the Ngatimaru, the Ngatihaua, and the Arawa, gradually acquired similar weapons, and thus fought on terms of greater equality; and it was also during this period, as mentioned in the last chapter, that Te Waharoa began to mature his designs for the destruction of the first of these tribes. I may here remark, that the trade referred to was almost confined to the Eastern side of the North Island, and that the tribes on the West Coast, at all events below the Manukau, had but little opportunity of obtaining the much coveted weapons. The wars in which Ngatimaru were engaged against Ngapuhi and Ngatihaua, and the want of a sufficient quantity of fire-arms amongst the tribes at Kaipara and Hokianga, coupled with their total absence amongst the other tribes on the West Coast, went far towards preventing Te Rauparaha from carrying out his designs against Waikato, whilst such designs became gradually less feasible, owing to the position of the latter, who, in consequence of the offensive and defensive alliance which they had formed with Te Waharoa, were enabled, without difficulty, to obtain supplies of muskets and ammunition.

When Te Rauparaha found it impossible to carry out his design, he returned to Kawhia, where, by a succession of victories over Waikato, and by the practice of hospitality, he greatly increased his power and influence with his own tribe, whilst he cultivated the friendship (due partly to good feeling, but largely to fear) of the Ngatiawa, who occupied the country to the southward, stretching from Mokau to Taranaki. He is represented

as having been, during this period, "famous in matters relative to warfare, cultivating, generosity, welcoming of strangers and war parties." He is also said to have been particularly remarkable for the following reason: "If a party of visitors arrived just as the food of his workmen was cooked, and if those workmen were strangers to his treatment of visitors, and gave them their food, he ordered them to take it back, saying that fresh food was to be cooked for the visitors. The workmen would then be ashamed, and Te Rauparaha applauded as a man whose fame had travelled amongst all the tribes. When the workmen were satisfied, Te Rauparaha would cook fresh food for the visitors, who, when they had partaken, would leave. Hence, amongst his tribe a saying is used, 'Are you Te Rauparaha? When his workmen are satisfied, food will be prepared for visitors.'"

It appears that in 1817, or about three years before E Hongi left for England, and after the failure of Te Rauparaha's attempt to form an alliance against Waikato, a large war party arrived at Kawhia under the command of Tamati Waka Nene and of his brother Patuone, who invited Rauparaha to join them in a raid upon the southern tribes. Tamati Waka's people had a considerable number of muskets on this occasion, but the expedition had no special object beyond slaughter and slave-making, with the added pleasure of devouring the bodies of the slain. Te Rauparaha joined them with many warriors, and the party travelled along the coast through the territory of the Ngatiawa whose alliance with Ngatitoa, however, saved them from molestation. Hostilities were commenced by an attack upon Ngatiruanui, who were dispersed, after great slaughter. This first success was followed by attacks on all the tribes on the coast until the *tava* reached Otaki, great numbers of people being killed, and many slaves taken, whilst the remainder were driven into the hills and fastnesses, where many of them perished miserably from exposure and want. At Otaki the invaders rested, Rauparaha visiting Kapiti, which he found in possession of a section of the Ngatiapa tribe, under the chiefs Potau and Kotuku. It would seem that even at this time Te Rauparaha, who was much struck with the appearance of the country, formed the design of taking possession of it, and, with his usual policy, determined, instead of destroying the people he found on the Island, to treat them with kindness, though he and the other leaders compelled them to collect and surrender much greenstone, of which this tribe especially had, during a long intercourse with the Middle Island, and by means of their own conquests of the Ngaitahu, obtained large and valuable quantities. The hostile party then continued their course along the coast, destroying great numbers of people. On their arrival at Wellington, then called Whanganui-a-tara, they found that the inhabitants—a section of the Ngatikahungunu—alarmed at the approach of the ruthless invaders, had fled to the Wairarapa. Thither followed the

taua, and discovered the Ngatikahungunu, in great force, at a pa called Tawhare Nikau. Undaunted, however, by the strength of the fortress, they attacked and carried it with great slaughter. Large numbers of the unfortunate inhabitants escaped to the hills, where they suffered greatly, whilst the invaders, after following the fugitives as far as Kawakawa and Porangahau, killing many, fell back upon Tawhare Nikau, in order to gorge themselves upon the bodies of the slain. The party then returned to Wellington and proceeded to Omere, where they saw an European vessel lying off Raukawa, in Cook Strait. Tamati Waka Nene, immediately on perceiving the ship, shouted out to Te Rauparaha, "Oh, Raha, do you see that people sailing on the sea? They are a very good people, and if you conquer this land and hold intercourse with them you will obtain guns and powder, and become very great." Te Rauparaha apparently wanted but this extra incentive to induce him to take permanent possession of the country between Wellington and Patea, and at once determined to remove thither with his tribe, as soon as he could make such arrangements as would secure him in the possession of his intended conquest. The *taua* returned along the coast line as they had first come, killing or making prisoners of such of the inhabitants as they could find as far as Patea. It was during the return of this war party that Rangihaieta took prisoner a woman named Pikinga, the sister of Arapata Hiria, a Ngatiapa chief of high rank, and whom he afterwards made his slave wife, a circumstance much and absurdly insisted upon in favour of the Ngatiapa title during the investigations of the Native Lands Court into the Manawatu case. Laden with spoil, and accompanied by numerous slaves, the successful warriors reached Kawhia, where Tamati Waka Nene and Patuone, with their party, left Te Rauparaha in order to return to their own country at Hokianga.

As I have before mentioned, Te Rauparaha had, during the progress of this raid upon the South, conceived the idea of leaving the ancient possessions of his tribe at Kawhia for the purpose of settling at Kapiti and upon the country on the main land in its vicinity; and accordingly, after the period of festivity and rest usually indulged in by a returned *taua*, he began to take the necessary steps, not only to induce his own people to accept his resolution, but to enlist the sympathies and assistance of his relatives at Maungatautari and elsewhere. During a visit which he paid for this purpose to the Ngatiraukawa, he found their great chief Hape Tuarangi in a dying state, and the circumstances which then occurred contributed greatly to the ultimate success of his designs. It appears that, notwithstanding the respect in which the offspring of the Maori aristocracy are usually held by their own people, and the influence they generally exercise in matters affecting the tribe, it is not unusual for the natural *ariki* of a tribe, or chief of a *hapu*, to be, in some

respects, supplanted by an inferior chief, unless the hereditary power of the former happens to be accompanied by intellect and bravery; and such an occurrence took place in regard to the natural hereditary *ariki* of the Ngatiraukawa at the death of Hape. Te Rauparaha himself, though by virtue of common descent, and by marriage ties, entitled to be treated as a chief of Ngatiraukawa, was not considered to be of high rank, on the grounds that, in the first place, he was the offspring of a junior branch of the *ariki* family of Tainui; and, in the next place, that the influence primarily due to his birth had been weakened by the intermarriage of his progenitors with minor chiefs and with women of other tribes. But when Hape, on his death bed, the whole tribe being assembled, asked "if his successor could tread in his steps and lead his people on to victory, and so keep up the honour of his tribe," not one of his sons, to whom, in succession, the question was put, gave any reply. After a long period of silence, Te Rauparaha, who was amongst the minor chiefs and people, sitting at a distance from the dying man and from the chiefs of high rank by whom he was surrounded, got up and said, "I am able to tread in your steps, and even do that which you could not do." Hape soon after expired, and as Te Rauparaha had been the only speaker in answer to his question, the whole tribe acknowledged him as their leader, a position which he occupied to his dying day. But even in this position his authority was limited, for though in his powers of mind, and as a leader of a war party, he was admittedly unsurpassed, either by Te Waharoa or by the great Ngapuhi chief, E Hongi, and therefore fully entitled to occupy a commanding position in the tribe, the *mana* which he acquired on the occasion in question extended only to the exercise of a species of protecting power and counsel whenever these were required, whilst the general direction of the affairs of the tribe still remained vested in their own hereditary chiefs. The influence he had obtained, however, materially aided him in ultimately inducing a large number of the tribe to join him in the conquest and settlement of the territory of the Ngatiapa, Rangitane, and Muaupoko, as will be shown in the sequel. It may seem strange that a people occupying the fertile slopes of the Maungatautari and the beautiful tract of country stretching along the Waikato to Rangiaowhia and Otawhao, could have been induced to abandon such a country in order to join in the conquest and settlement of a distant, and not more fertile, territory; but it must be remembered that, at the time in question, the whole Maori people were engrossed by one absorbing desire—that of acquiring fire-arms—and the inland position of the Ngatiraukawa, and their known wealth in much that the natives then considered valuable, invited attack, whilst the former circumstance prevented them acquiring to any extent the much coveted European weapons. It is true, that through their relatives at Rotorua they succeeded, from time to time, in obtaining some

muskets and ammunition, but the quantity was not sufficiently large to afford them the means of successfully resisting the probable attacks of the tribes nearer the coast, whose opportunities of trade with the whale ships enabled them to acquire an abundant supply of both, as well as of tomahawks and other iron weapons of the most deadly character. Te Rauparaha, no doubt, represented to them the probability of obtaining similar supplies from ships frequenting the shores of Cook Strait, whilst the severe blow inflicted on the tribes occupying the territory in question, by the war party under Tamati Waka Nene, Patuone, and himself, afforded a prospect of easy victory. It was not, however, until after he and his people had reached Taranaki, in the course of their migration, that he succeeded in inducing Watanui, one of the principal chiefs of the Ngatiraukawa, to concur in his project, under circumstances which will be related hereafter. In the meantime, he and his own tribe made up their minds to leave, and finally departed from Kawhia in 1819 or 1820; but I reserve, for the next chapter, the account of this highly interesting event, and of those which took place during their subsequent journey southward.

CHAPTER IV.

THE voluntary migration, from their ancestral possessions, of an independent and comparatively powerful tribe like the Ngatitoa, with a view to the conquest and settlement of a new territory, must, under any circumstances, be looked upon as a remarkable event in the later history of "Old New Zealand;" but our wonder at the undertaking ceases, when we reflect upon the peculiar position occupied by this tribe—and, in fact, by all the tribes on the western coast of the North Island, to the South of the Manukau—at the period when it took place, more especially with reference to the opportunity of acquiring fire-arms, which had become an absolute necessity to any tribe desirous of maintaining a separate independent existence, whilst we are forced to admire the sagacity of the chief who conceived, and of the people who adopted, such a design. There can, indeed, be little doubt that had the Ngatitoa attempted, in the then changed circumstances of native warfare, to retain possession of their ancient territory against the increasing power of the Waikatos, more particularly after the alliance of the latter with Te Waharoa, they would certainly have been annihilated.

I ought to have mentioned in the last chapter, that in the long period during which the Ngatitoa, Ngatiawa, and Ngatitama occupied adjoining districts, frequent intermarriages took place between members of these tribes, so that the leading chiefs, especially, of each came to be connected with those of the others by ties of blood. Te Rauparaha himself was in this position, and this circumstance, added to his great fame as a warrior and

statesman, gave him an influence in the councils of Ngatiawa and Ngatimata, which was of much value and importance to him, in the furtherance of his immediate projects, whilst they ultimately led to his example being followed by those tribes, after the severe losses inflicted upon them by Te Wherowhero and the Waikatos at Puke-rangiora. It appears, indeed, that long before this blow fell upon them, Te Rauparaha had pointed out the danger to which they would be exposed at the hands of the Waikato chief, when he and his people no longer stood between them and the latter, but the united Ngatiawa and Ngatitama were at that time a very powerful tribe, their ancient *mana* as warriors extending through the length and breadth of the land, and they ridiculed the possibility of serious defeat or disaster befalling them, and even urged Te Rauparaha himself to abandon his design, as unnecessary, and as being incompatible with the honour of his tribe. But the sagacious chief of the Ngatitoa had seen the change produced in the relative positions of the Ngapuhi and Ngatiwhatua, on the one side, and of Ngatimaru and other Thames people on the other, owing to the opportunities possessed by the former of acquiring, in abundance, the powerful European weapons, and he had early appreciated the fact, that in all future contests in New Zealand, the party which could only bring the wooden spear and battle-axe into the field, against the musket and the bayonet, must eventually be destroyed. On this point, very decisive testimony is given by Major Cruise, of the 84th Regiment, in his account of his residence in New Zealand in 1819 and 1820. He mentions that, on the arrival of the "Dromedary" store ship at the Bay of Islands, for the purpose of taking in a cargo of kauri spars, they found the people of the Bay daily expecting the return of a numerous war party, which had started some months previously for the purpose of attacking the natives at the River Thames. Shortly afterwards, in effect, this party arrived at the head of the bay, and he and some of the other officers of the "Dromedary," went to meet it. The returned party occupied a fleet of about fifty canoes, many of them seventy or eighty feet long, and few less than sixty; all of them were filled with warriors, who stood up and shouted as they passed the European boat, holding up numbers of human heads as trophies of their success. The barter of powder and muskets, he says, carried on by the whalers, had already distributed some hundred stand of arms amongst the inhabitants of the Bay, and as the natives at the Thames were unprovided with similar weapons, they made little opposition to their more powerful invaders, who, in that instance, told him that they had killed 200, whilst they returned with the loss of only four men. Tui, one of the principal chiefs of the Bay, in a conversation with Major Cruise on this occasion, made one continued boast of the atrocities he had committed during an excursion to the same place about two months before, and dwelt with marked pleasure upon

an instance of his generalship, when, having forced a small party of his enemies into a narrow place, whence there was no egress, he was enabled, successively. to shoot twenty-two of them, without their having the power of making the slightest resistance. Now, such facts as these were well known to Te Rauparaha, and satisfied him that the utmost valour, backed even by very superior numbers, must be of no avail against a weapon of so deadly a character as the musket, when wielded by so daring and bloodthirsty a people as the New Zealanders. He, therefore, never wavered in his design, and from the time when Tamaki Waka Nene pointed out the ship sailing in Cook Strait, until his actual departure from Kawhia at the head of his people, his mind and his energies were constantly engaged in devising the means of carrying it to a successful issue. It was not, however, until upwards of two years after the return of the war party, mentioned in the last chapter, that the necessary arrangements for the migration were completed, and during this interval he frequently visited the Ngatiraukawa, at Maungatautari, for the purpose of urging them to join him, whilst he also held constant intercourse with the chiefs of Ngatitama and Ngatiawa, in regard to the assistance his people would require from them, whilst passing through their territory. I must caution my readers from inferring from the relationship and general friendliness which existed between the Ngatitoa and the Ngatiawa, that either of these tribes would have felt much delicacy or compunction in destroying the other. At the period in question, more, perhaps, than during any other in the history of the race, moral considerations had but little weight in determining the conduct either of the individual or of the tribe. The ruthless wars which were then being prosecuted all over the North were rousing, to the highest pitch, the savage instincts of the race, and even the nearest relatives did not hesitate in destroying and devouring each other. Of this utter abandonment of all moral restraint many frightful instances might be quoted, but the fact is too well known to those who are acquainted with the history of the New Zealanders during the thirty years preceding the colonization of the Islands by the Europeans to require demonstration here.

But however essential to the success of the enterprise were the friendship and co-operation of Ngatiawa, it was no less necessary that Te Rauparaha should be enabled to effect his object without danger of molestation from his old enemies, the Waikatos, who would naturally be disposed to take advantage of any favourable circumstance, in connection with the event in question, in order to wreak their vengeance upon a foe from whom they had received many disastrous blows. In the last chapter, I mentioned that the Ngatimaniapoto, then occupying the country extending along the coast to the northward of Kawhia, were connected by common descent, as well as by intermarriages, with the Ngatitoa; and I may now add that, although

occasional disputes took place between these two tribes, they had always lived on terms of friendship, and usually made common cause against an enemy. But the Ngatimaniapoto were also, in a considerable degree, connected with the Waikato tribes, under the leadership of Te Wherowhero; and Rauparaha, determined to make use of this double connection in order to establish a firm peace between himself and the great Waikato chief before he commenced his movements towards the south. Through the influence of Kukutai and Te Kanawa, with both of whom Te Rauparaha was on good terms, he succeeded, very soon after his return from the expedition under Waka and himself, in inducing Te Wherowhero to agree to a cessation of hostilities, whilst he also informed them of his intention to leave Kawhia, with his people, and promised to cede it to Te Wherowhero on his departure. The easy acquisition of so valuable a territory was naturally looked upon by this chief as a matter of great moment to his people, besides the even more important circumstance attaching to it, namely, that the removal of a powerful enemy would enable him to concentrate his forces along his eastern frontier, so as to keep in check the increasing power of Te Wahoroa, whom he dreaded, notwithstanding that an alliance then existed between them. The proposed peace was accordingly made, and Te Rauparaha and his people being thus as secure as could be expected against attack on the part of the Waikatos, and having made satisfactory arrangements with Ngatitama and Ngatiawa for their passage through the territory of the latter, proceeded to make final preparations for departure. The principal point in this respect was the necessity of providing for a supply of food during the journey, which must obviously be a slow one on account of the aged, and of the women and children, whilst the distance was too great to be accomplished within a single season, and it was essential, therefore, to establish resting places where cultivations could be carried on in order to provide for the continuation of the march in the ensuing year. In the next place, Te Rauparaha knew that he could not conceal his intentions from the tribes whom he was about to invade; and that, although their power had been greatly shaken during the previous raid, he could scarcely hope to occupy their territory without further resistance. It was, therefore, necessary to provide for the contingencies which the possibility of such resistance naturally involved, and this could only be done by a careful management and disposition of the forces under his command, and by securing the co-operation of some of his more immediate relatives and allies. Testing his foresight in all these matters by the ultimate success of his enterprise, we are entitled to believe that the arrangements he made were well calculated to ensure the safe accomplishment of his design; and we know, at all events, that during the interval which took place between the peace with Te Wherowhero and the actual departure of himself and his people from Kawhia, Te Rauparaha took

care to provide for such supplies of food as would carry them through the first stage of their intended journey, whilst he also determined in detail the principal arrangements for the entire march. These preparations having all been satisfactorily completed by the beginning of the year 1819, he visited Waikato, for the last time, in order to bid farewell to Kukutai, to Pehikorehu, to Wherowhero, to Te Kanawa, and to all the chiefs of Waikato, saying to them, "Farewell; remain on our land at Kawhia; I am going to take Kapiti for myself, do not follow me." He then returned to Kawhia, where he at once assembled his tribe and started for the South, the number leaving Kawhia itself, including persons of all ages, being about 400, of whom 170 were tried fighting men. On the morning of the day of their departure, he and his people came out of their pa at Te Arawi, having previously burned the carved house named Te Urungu-Paraoa-a-te-Titi-Matama. They then ascended the hill at Moeatoa, and looking back to Kawhia were very sad at leaving the home of their fathers. They cried over it, and bade it farewell, saying, "Kawhia remain here! The people of Kawhia are going to Kapiti, to Waipounamu."

Savage, even ruthless, as those people may have been, we can still understand their sorrow at leaving their ancestral possessions. "The love of the New Zealander for his land is not," says Mr. White (from whom I have before quoted on this point), "the love of a child for his toys. His title is connected with many and powerful associations in his mind; his love for the homes of his fathers being connected with the deeds of their bravery, with the feats of his own boyhood, and the long rest of his ancestors for generations." Every nook and inlet of the beautiful harbour of Kawhia was endeared to the departing people, not only by its picturesque beauty, which the New Zealander fully appreciates, but also by its association with the most ancient traditions of the tribe. Every hill, every valley, was connected, in their memory, with scenes of childish joy, whilst many of the singular and gloomy caverns in which the district abounds, were crowded with the remains of their ancestors, and were the subjects of their reverence and awe; and from these circumstances, not less than from the uncertainty which necessarily hung over the future of the tribe, we may estimate the strength of their faith in the sagacity of the chief who had induced them to embark in so remarkable a project.

The march was at length commenced, and at the end of the third or fourth day the people arrived at the Pa of Puohoki, where Te Rauparaha determined on leaving, under a sufficient guard, a number of the women (including his own wife, Akau) who, by reason of pregnancy, was unfit for travel. The remainder of the tribe continued their journey, and settled for the season at Waitara, Kaweka, and Taranaki, living in the pas of the Ngatiawa and

Ngatitama. Shortly after this, Te Rauparaha determined to return to Te Puohu's pa, in order to bring up the women who had been left behind, and selected twenty of his warriors to accompany him. His tribe were unwilling that he should undertake this expedition with so small a number of men, urging him to go in force in order to prevent the risk of any treacherous attack upon his party. Te Rauparaha, however, insisted on limiting his followers to the twenty men he had chosen, and started on his journey. On crossing the Mokau River, he found the body of Rangihaieta's only child, who had been drowned from Topiora's canoe, as she and part of the tribe came down the coast during the general migration. It was in order to commemorate this circumstance, that the name Mokau, as a nickname, was assumed by Te Rangihaieta. Te Rauparaha wrapped the body of the child in his clothing, and carried it with him to Puohu's pa, where it was interred with due solemnity. On his arrival, he found the women and the people he had left all safe, and at once made arrangements for removing them to Waitara. In the meantime his wife, Akau, had given birth to Tamihana, who is now living at Otaki. On the third day after his arrival the party left the pa, Te Rauparaha carrying his infant child on his back in a basket. Just before reaching Mokau, it being dusk, they were threatened by a considerable war party of Ngatimaniapoto, who had crept down the coast after the evacuation of Kawhia and the surrounding district, and Rauparaha had strong reason to fear that he and his people would be attacked and cut off. By a clever stratagem, however, he imposed upon the enemy, for, after clothing twenty of the women in men's mats, and placing feathers in their hair, and arming them with war clubs, he sent them forward under the charge of his wife, Akau, a woman of commanding stature, and who, on this occasion, wore a red mat named Hukeumu, and brandished her weapon and otherwise acted as if she were a redoubtable warrior, whilst Te Rauparaha himself covered the retreat with the men, the remainder of the party marching between these two bodies.

The Ngatimaniapoto, mistaking the strength of Te Rauparaha's force, commenced a retreat, but were attacked by him, and five of their number killed, amongst whom was Tutakara, their leader, who was slain by Rangihoungariri, a young relative of Te Rauparaha's, already renowned as a warrior. The party then continued their march and reached the Mokau River at dark, but were unable to cross it in consequence of its being swollen by rain and the tide being high. Rauparaha knew that the danger was not over, and that the Ngatimaniapoto would, under cover of night, attempt to take revenge for their loss. He therefore ordered twelve large fires to be made, at some distance from each other, and three of the women of the party, still disguised as men, to be placed at each fire, to which he also assigned one of his warriors, whilst he, with the remainder, acted as scouts. The men near

the fires were to keep watch during the night, and occasionally to address the others, saying, " Be strong, oh people, to fight on the morrow if the enemy return. Do not consider life. Consider the valour of your tribe." Besides this, the women were directed to make much noise with their speeches, so that Haiki even might hear their voices. This further stratagem appears completely to have deceived Ngatimaniapoto, who did not attempt to molest them any further. During the night, however, a peculiar incident, illustrative of Maori life, occurred, which might have been productive of disaster but for the course taken by Te Rauparaha. Amongst the women who were with the party was Tangahoe, the wife of a chief, who had an infant with her. This child in its restlessness began to cry, and Te Rauparaha, fearing that his stratagem would be betrayed by the cries of the child, told its mother to choke it, saying " I am that child." The parents at once obeyed the command, and killed the child. Towards midnight the river fell considerably, and at low tide the party left their fires and crossed it, continuing their march until they reached a pa of the Ngatitama, greatly rejoicing at their escape. Early on the following morning Rauparaha's party, with a reinforcement of Ngatitama and Ngatiawa, returned to the spot where the fight of the previous afternoon had taken place, and secured the bodies of Tutakara and the others who had been killed. These were taken to Mokau, where they were cut up and eaten, amidst great rejoicings on the part of Ngatiawa and Ngatitama at the chance thus afforded them of paying off some old grudge which they had against Ngatimaniapoto. The success of the stratagems employed by Te Rauparaha on this occasion, added greatly to his renown as a warrior, and, moreover, invested him with an attribute of almost sanctity, not only in the eyes of his own tribe, but also in those of his allies. Te Rauparaha then joined the main body of his people, who were engaged in the necessary preparations for the resumption of their migration.

Shortly after this, it would appear that Te Wherowhero and Te Waharoa, deeming the opportunity a good one for striking a deadly blow against Rauparaha, had collected a large force at the head of the Waiapa, with which they marched upon Taranaki, intending to attack the Ngatitoa at Motunui, before the latter could obtain any material assistance from Ngatiawa or Ngatitama, the main body of whom were chiefly stationed at Te Kawaka, Urenui, and other places. The plans of the Waikato leaders were so carefully laid in this respect, that Rauparaha received no intimation of their advance until they were close upon him, but he at once sent intelligence to Kaiaia, the leading chief of the Ngatitama, since better known by the name of Ta Ringa Kuri, with instructions to join him at Motunui. However, before Kaiaia could come to his assistance he assembled his own forces, including a small body of Ngatiawa ; and, having a better knowledge of the country

than the enemy, he fell upon them suddenly, his forces attacking in a compact body. After encountering an obstinate resistance, he succeeded in completely routing them with a loss of nearly 150 men, including the principal chiefs Hiakai and Mama, whilst many other chiefs, and a large number of inferior people, were taken prisoners. The latter were hung, and their bodies, as well as those of the men who had fallen in the battle, were duly devoured, with all the ceremonies attendant upon such a feast after a great and successful battle. Te Wherowhero and Waharoa were the only great chiefs of note who escaped on this occasion, the slaughter of leaders having been peculiarly heavy, and even they owed their lives to the connivance of Rauparaha, who, apparently for reasons of his own of which I am not informed, but possibly to avoid driving them to desperation, did not care to attack them on the following day. It is said, whether truly or not I cannot decide, that Te Waharoa did not exhibit his usual bravery on this occasion, but had fled early in the day. It appears, too, that had Kaiaia's portion of the Ngatitama arrived in time to take part in the battle, the whole of the Waikato force would have been destroyed. Be this as it may, during the night after the battle Te Wherowhero approached the camp of the Ngatitoa, and cried out to Te Rauparaha, "Oh, Raha, how am I and my people to be saved?" Te Rauparaha replied, "You must run away this night. Do not remain. Go, make haste." Te Wherowhero and his men fled during the night, leaving their fires burning; and when Kaiaia's forces came up on the next morning they found the Waikato camp deserted, whilst the bodies of many of those who had been wounded in the previous day's engagement, and had died during the night, were left behind. These bodies were at once cut up and devoured by Ngatitama, Te Rauparaha and his people joining in the feast.

After all danger of further attack on the part of Waikato had ceased, Te Rauparaha determined, before resuming the movement southward, again to visit his friends at Maungatautari, in order to induce the latter, if possible, to join him in the expedition. For this purpose he travelled to Taupo taking the road from Taranaki by the Upper Wanganui and Tuhua. At Tuhua he had a long conference with Te Heuheu, who promised to afford him any assistance he could in effecting his settlement at Kapiti and on the main land, but would not consent to take any other part in the undertaking. He then proceeded to Opepe, on Lake Taupo, where a large number of the Ngatiraukawa had assembled, under Whatanui, in order to discuss Te Rauparaha's proposals. Here a great *tangi* was held, at which Whatanui made a speech to Rauparaha, and gave him many presents, as they had not met for a length of time. After the ordinary ceremonies were concluded, Te Rauparaha again opened his proposals to the assembled chiefs, representing

the many advantages that would accrue from adopting them, and particularly insisting on the opportunity it would give the tribe of obtaining abundant supplies of fire-arms, as Kapiti and other parts of Cook Strait had already begun to be visited by European ships. He also dwelt on the rich and productive character of the land, and the ease with which it might be conquered, whilst there was nothing to prevent, at the same time, a large number of the tribe from remaining at Maungatautari, in order to retain their ancient possessions there. To all this, however, Whatanui gave no reply, and the meeting broke up without any indication that any part of the tribe would join in the proposed expedition. Te Rauparaha then visited other sections of the tribe, and another great meeting took place, at which he was not present. At this meeting the chief objection raised was, that by joining Te Rauparaha he would become their chief, and there was an unwillingness on the part of the tribe, notwithstanding what had occurred at the death of Hape, entirely to throw off their allegiance to their own hereditary *arikis*. This resolution was communicated to Te Rauparaha by Horohau, one of the sons of Hape, by Akau, then Rauparaha's wife, and the reasons specially assigned for it grieved Te Rauparaha very much. Seeing the apparent impossibility of inducing Whatanui's people to join him in his project, he went on to Roturoa, and ultimately to Tauranga, where he urged Te Waru to join him. Te Waru, however, refused to leave Tauranga on account of his love for that place, and for the Islands of Motiti and Tuhua. Whilst Te Rauparaha was at Tauranga, news reached that place that Hongi Heke, with the Ngapuhi, was besieging the great pa of the Ngatimaru at the Thames, which, after some delay, they took, as mentioned in a former chapter, slaughtering great numbers of the inhabitants. Amongst others of the killed on this occasion, were the infant children of Tokoahu, who had married a grand-niece of Rauparaha's. He appears to have been greatly exasperated at the absurd manner in which the people of this pa had permitted it to be taken, and at the destruction of his relatives, and at once went over to Roturoa, whither another *taua* of the Ngapuhi, under Pomare, had proceeded after the defeat of the Ngatimaru. Here he had an interview with Pomare, and expressed his determination to kill some of the Ngapuhi as a payment for the slaughter of Tokoahu's children, to which Pomare consented, he being also in some degree connected by marriage with Tokoahu. The Ngapuhis, accompanied by Te Rauparaha, proceeded to Paeoterangi, where Tuhourangi and some others were duly sacrificed, with great solemnity, in order to appease the *manes* of Tokoahu's children. Pomare then gave over to Rauparaha a number of men who had been under the leadership of Tuhourangi, who, from that time, became attached to and incorporated with Ngatitoa, and accompanied him on his return to Taranaki shortly after the sacrifice in question. On reaching Taranaki, he made

preparations for continuing the migration, and succeeded in inducing Wi Kingi Rangitake, since celebrated in connection with the Waitara war, and his father, Reretawhangawhanga, with many other chiefs, and a considerable number of the Ngatiawa tribe, to accompany him, his followers then consisting of his own people (the Ngatitoa), numbering 200 fighting men, of the Ngapuhis who had been transferred to him by Pomare, and of Wi Kingi's Ngatiawas, numbering nearly 400 fighting men, and their several families. During the interval between the commencement of the migration and its resumption from Taranaki, after Te Rauparaha's last return thither, a large war party of Waikatos, under Tukorehu, Te Kepa, Te Kawau (Apihai), and other chiefs, had descended the East Coast, from whence they invaded the territory which Te Rauparaha was about to seize. The Muaupoko, Rangitane, and Ngatiapa, were all attacked on this occasion, and again suffered great loss, a circumstance which became known to Te Rauparaha through some Ngatiraukawa men who had joined the Waikatos in their expedition, and had communicated its results to him during his last visit to Maungatautari. It appears, moreover, that after he had left Taupo, Whatanui and a large party of Ngatiraukawa made up their minds to join him at Kapiti, but instead of following the same route which he intended to take, they determined to proceed *viâ* Ahuriri, having been invited thither by the Ngatikahungunu, for some purpose which I cannot clearly make out. On their arrival there, however, a dispute took place between the two parties, and a battle ensued, in which the Ngatiraukawa were defeated with considerable slaughter, the remainder of the party being forced to retreat upon Maungatautari. Late in the autumn of 1819, no doubt after the ordinary crop of kumera had been gathered in, Te Rauparaha resumed the march, which was uninterrupted until they reached Patea, where five of the Ngatitoa men, and a male slave of Topiora's named Te Ratutonu, who had formerly been a chief, were murdered. To avenge this murder, Rauparaha killed a number of the people occupying Waitotara, and thence his party proceeded to Wanganui, the greater portion of the women and children travelling along the coast in canoes, whilst the warriors, with most of the leading chiefs, travelled by land, Rauparaha himself, however, travelling by water in a large canoe taken from the Waitotara people. I may here incidentally mention that his designs, at this time, were not confined to the acquisition of Kapiti, and the adjacent country; he had also made up his mind to invade the Middle Island after he had become well settled in his new abode, in order to obtain the great treasures of green-stone which were believed to be in possession of the people of that island. Of course, he could only hope to effect this by obtaining a number of large canoes, and, to use the words of his son, "canoes were at that time his great desire, for by them only could he cross over to the Island of Waipounamu." Amongst the

leading chiefs who accompanied Rauparaha, was Rangihaieta, who, as will be remembered, had, during the previous invasion, taken prisoner a Ngatiapa woman of rank named Pikinga, whom he had made his slave-wife. When her brothers heard of the arrival of Ngatitoa at Wanganui, they, with a party numbering altogether twenty men, came to meet her, and accompanied Ngatitoa as far as the Rangitikei river, for, as the weather continued extremely fine, Te Rauparaha thought it desirable to push the advance as rapidly as possible. On arriving at the mouth of the Rangitikei the people rested for some days, those in the canoes landing for that purpose. During this rest, armed parties were sent inland, in various directions, for the purpose of capturing any stray people whom they could find, in order that they might be killed and eaten; but these parties found the country nearly deserted, the remnant of the original tribes having taken refuge in the fastnesses of the interior. Te Rauparaha then pushed on to the mouth of the Manawatu, where he and his people again halted, parties here, also, going inland in search of Rangitane, with the same intentions with which they had previously sought the Ngatiapa, and with very much the same result. Their next stage was Ohau, where Ngatitoa settled until after they had taken Kapiti, as will be mentioned in the sequel. During this time the Muaupoko occupied the country inland of Ohau and stretching to the Manawatu River, having a pa on Lake Horowhenua, and on the banks of Lake Papaitanga, which is close to it. Shortly after Rauparaha had settled at Ohau two of the chiefs of Muaupoko visited him, and offered, if he would come over to their pa at Papaitanga, to make him a present of several large canoes. He was extremely delighted at this offer, and at once consented to go. Rangihaieta, however, endeavoured to dissuade him, saying, "Raha, I have had a presentiment that you will be murdered by Muaupoko," but Rauparaha laughed at his fears; and, attracted by the prospect of obtaining the canoes—which had been glowingly described to him by the two chiefs—would not listen to any suggestions against the proposed visit. He even refused to take any large force with him, confining himself to a few men, and to some of his own children. It appears, however, that a plot had been laid between Turoa and Paetahi (father of Mete Kingi, lately one of the Maori members of the Assembly), chiefs of the Wanganui tribes, and the leading chiefs of the Muaupoko, to murder Te Rauparaha, and the invitation to Papaitanga, with the offer of the canoes, were only steps in the plot for that purpose. It is quite clear that he apprehended no danger, and that he fell into the trap laid for him with wonderful facility. It was evening when he and his companions arrived at the pa, where they were received by Toheriri, at whose house Rauparaha was to sleep. His people were all accommodated in different parts of the pa, Rauparaha alone remaining with Toheriri. The

murder was to be committed at night by a war party from Horowhenua, and when Toheriri believed that his guest was fast asleep, he rose and went out, intending to inform the war party that Rauparaha was asleep in his house. His movements, however, aroused Te Rauparaha, who at once suspected some foul design, a suspicion which was soon converted into certainty by the cries of some of his people at the commencement of the bloody work. He then escaped from the house, and, being entirely unarmed, fled towards Ohau, which he succeeded in reaching, but quite naked. During the attack Rangihoungariri, who, it will be remembered, distinguished himself when Rauparaha's party were attacked by Ngatimaniapoto, near the River Mokau, had succeeded in getting well away, but hearing Hira's sister calling out to him that she would be killed, at once returned to her aid, but was soon overwhelmed by numbers and slain, Te Poa, Hira's husband, having been killed previously. Hira, and a girl named Hononga, were not killed, but were carried off to Ruamahunga, in the Wairarapa, where the former afterwards married Taika, a distant relation of Rauparaha's. These two girls were the daughters of that Marore whom I mentioned in a former chapter as having been his boy wife. This treacherous murder provoked the wrath of Ngatitoa, who, from that time, proceeded to destroy Muaupoko without mercy. Toheriri was taken prisoner, and afterwards hung and eaten, undergoing dreadful tortures. Before this event Muaupoko were a somewhat powerful tribe, but their power was utterly broken by the Ngatitoa and their allies, in revenge for the attempted murder of their great chief. After this escape Rauparaha settled at Ohau, and occupied the main land as far as Otaki, his war parties constantly hunting the people at Rangitikei, Manawatu, and Horowhenua; but a remnant of these tribes still held Kapiti, notwithstanding several attempts to take possession of it.

Chapter V.

Amongst the chiefs who accompanied Te Rauparaha in the migration, was his uncle, Te Pehi Kupe, who, by virtue of his seniority of age and rank, was undoubtedly entitled to the leadership of the tribe; but, although not deficient in talent, and admittedly a great warrior, he was inferior to his nephew in those special qualifications, which had enabled the latter to acquire the power he held over his own tribe, and the influence he exercised in the councils of the Ngatiawa and Ngatiraukawa. It has, however, been asserted that there are grounds for believing that Rauparaha was somewhat jealous of Te Pehi, and that dreading the possibility of an attempt on the part of the latter to assume the leadership of the tribe in virtue of his higher social position, he would not unwillingly have sacrificed him. Indeed, it is said, that the taking of Kapiti was primarily due to a

treacherous act on his part, committed for the express purpose of involving Te Pehi, and a number of other members of the tribe, in destruction; but it is difficult to suppose that Rauparaha could have maintained his high position if this charge, and others of a similar nature, were in any degree well founded. My own impression is that the whole affair was planned for the express purpose of throwing the defenders of Kapiti off their guard, and so of securing a conquest which had already been several times attempted in vain, but which he felt to be absolutely necessary for the success of his ultimate designs. It appears that one day he started with a large force of Ngatitoa and Ngatiawa for Horowhenua, for the avowed purpose of harrassing the remnant of Muaupoko and Rangitane who still wandered about that district, and that before dawn of the morning after his departure (which had been made known on the previous day to the people on the Island through their own spies), Te Pehi, and his own immediate followers, crossed the Strait and attacked them. Thrown off their guard by the knowledge of Rauparaha's absence with the bulk of the warriors, they had neglected their ordinary precautions against surprise, and were easily defeated, many being slain, although the greater number escaped in their canoes to the main land, and found refuge in the forests and swamps of the Manawatu. On the return of Rauparaha's war party, he at once passed over to Kapiti, where he usually resided from that time until his death. Shortly after the taking of Kapiti, Wi Kingi and the great body of the Ngatiawa returned to the Waitara, only twenty warriors remaining with the Ngatitoa. Thus weakened, they were ultimately compelled, by events which I am about to relate, to abandon their settlements on the main land, and to remove to Kapiti, where they formed and occupied three large pas, one named Wharekohu, at the southern end of the Island; another named Rangatira, near the northern end; and one named Taepiro, between the other two, Te Rauparaha and Rangihaieta, with the main body of the people, residing in the latter. Before relating the events which took place after the departure of the Ngatiawa, it is necessary that I should call attention to many affairs of importance which occurred between that event and the first settlement of the Ngatitoa at Ohau. It will be remembered that at the close of the last chapter I mentioned the attempt made by the Muaupoko to murder Rauparaha, near Lake Papaitanga, and the determination of himself and his tribe to lose no opportunity of taking vengeance for the slaughter which had taken place on that occasion. At the time of this occurrence, the Muaupoko were still numerous and comparatively powerful, having suffered much less during the previous incursions of the Ngapuhi and Waikatos, than the neighbouring tribes; but they were, nevertheless, no match for the better armed and more warlike Ngatitoa, and therefore rarely met them in the open field, relying for security rather upon the inaccessibility

of their fortresses and upon their intimate knowledge of the fastnesses of the Manawatu district, than upon their prowess in the field. They then occupied a number of pas in the country around Lakes Papaitanga and Horowhenua, as well as several which they had erected upon artificial islands in the latter lake, in the manner so interestingly described by the Reverend Mr. Taylor, in a paper recently read before this Society. Now, it appears, that in pursuance of his intention to destroy these people, Rauparaha constantly detailed war parties to attack them, as well as to harrass the unfortunate remnant of the Rangitane who still lurked in the country to the northward of their territory.

Finding themselves unable to check these attacks, the Muaupoko took refuge in the Lake Pas, which the Ngatitoa however, determined to attack. Their first attempt was on that named Waipata, and, having no canoes, they swam out to it, and succeeded in taking it, slaughtering many of the defenders, though the greater number escaped in their canoes to a larger pa on the same lake, named Wai-kie-kie. This pa was occupied in such force by the enemy, that the party which had taken Waipata felt themselves too weak to assault it, and, therefore, returned to Ohau for reinforcements. Having obtained the requisite assistance, they again proceeded to Horowhenua, and attacked Wai-kie-kie, using a number of canoes, which they had taken at Waipata, for the purpose of crossing the lake. After a desperate, but vain resistance, they took the pa, slaughtering nearly 200 of the inhabitants, including women and children, the remainder escaping in their canoes, and making their way, by inland paths, in the direction of Paikakariki, where they ultimately settled. In the course of these several attacks, a number of the leading Muaupoko chiefs were taken prisoners, all of whom, except Ratu, who became the slave of Te Pehi, were killed, and their bodies, as well as those of the people slain in the assaults, duly devoured. It is matter of note that, notwithstanding the occasional murder of men of the Ngatiapa who happened to be found on the south side of the Rangitikei River by the Ngatitoa and Ngatiawa war parties, Rauparaha had, up to this time, preserved friendly relations with that tribe, some of whom occasionally fought in his ranks; this was chiefly owing to the connection of Rangihaieta with Pikinga, but events which occurred shortly after the expulsion of the Muaupoko from the Horowhenua country, led to a rupture of this friendship and to the ultimate complete subjugation of the Ngatiapa. It was after the defeat of the former at Wai-kie-kie that the Ngatiawa returned to Waitara, but although, as I have before observed, their departure greatly weakened Rauparaha, he and his people still maintained their settlements on the main land, and continued their raids against the remnants of the defeated tribes. Amongst the expeditions thus undertaken one, in which a larger force than usual was

engaged, was directed against a pa at Paikakariki, occupied by the Muaupoko who had fled from Waikiekie, which was taken after an obstinate struggle, in which many of the occupants were slain, the conquerors remaining in possession for nearly two months for the purpose of consuming their bodies and the stores of provisions they found in the pa. They were there suddenly attacked by the Ngatikahungunu from Wanganuiatera and the surrounding country, and driven upon Waikanae with considerable loss. This event, coupled with the threatening attitude assumed by that powerful tribe, and the fact that the remnants of the Muaupoko, Rangitane, and Ngatiapa, were again collecting in the vicinity of their former settlements, determined Rauparaha to abandon the main land, and to withdraw the whole of his people to Kapiti until he could obtain the assistance (which he still confidently expected) of his kindred at Taupo and Maungatautari. He had no sooner retired to Kapiti, than the Rangitane erected a large pa at Hotuiti, on the north side of the Manawatu, within the tract now known as the Awahou Block, where they collected in force, and were joined by three Ngatiapa chiefs of note. Rauparaha hearing of this, determined to attack them, and he and Rangihaeata marched to Hotuiti with a well appointed *taua*, accompanied by Pikinga, who, on the arrival of the party before the pa, was sent into it to direct the Ngatiapa chiefs to retire to the district occupied by that tribe on the north side of the Rangitikei river. This they declined to do, and Rauparaha then sent messengers to the Rangitane, offering peace, and desiring that their chiefs should be sent to his camp to settle the terms. Being advised by the Ngatiapa chiefs to accept the offer, they sent their own head men to Rauparaha's quarters, where they were at once ruthlessly slain, and whilst the people in the pa, ignorant of this slaughter, and believing that hostilities were suspended, were entirely off their guard, it was rushed by the Ngatitoa, and taken after a very feeble resistance, the greater number of the unfortunate people and their families, as well as the three Ngatiapa chiefs, being slaughtered and devoured, such prisoners as were taken being removed to Waikanae in order to undergo the same fate. After this treacherous affair, Rauparaha and his force returned to Waikanae, where they indulged in feasting and rejoicing, little dreaming that any attempt would be made to attack them. It appears, however, that the Ngatiapa at Rangitikei, incensed at the slaughter of their three chiefs, determined to revenge their loss, and for this purpose had collected a considerable war party, which was readily joined by the refugees from Hotuiti and by a number of Muaupoko from Horowhenua. Led by Te Hakeke, they fell upon the Ngatitoa at Waikanae during the night, killing upwards of sixty of them, including many women and children, amongst the latter being the four daughters of Te Pehi. At the commencement of the attack, a canoe was despatched to Kapiti for reinforcements, which were at once sent, and

upon their arrival the enemy fled, but without being pursued. In consequence of this attack, Rauparaha and Rangihaeata became (to use the words of Matene Te Whiwhi) "dark in their hearts in regard to Ngatiapa," and resolved to spare no efforts to destroy them, as well as the remnants of Rangitane and Muaupoko.

Rauparaha had, of course, become aware of the defeat of Whatanui and the Ngatiraukawa in their attempt to reach Kapiti by the East Coast, but immediately after the departure of the Ngatiawa he had sent emissaries to Taupo, in order again to urge upon the chiefs to join him in the occupation of the country he had conquered. In the meantime, however, a storm was brewing which threatened utterly to destroy him and his people. Ratu, the Muaupoko chief who had been enslaved by Te Pehi, escaped from Kapiti and fled to the Middle Island. Being anxious to avenge the destruction of his tribe, he proceeded to organize an alliance between the tribes occupying the southern shores of Cook Strait and those which held the country from Patea to Rangitikei, on the North, and the Ngatikahungunu at Wanganuiatera and Wairarapa, on the South, for the purpose of attacking Rauparaha with a force, which, in point of numbers, at least, should be irresistible. In the formation of the desired alliance he was completely successful, and about the end of the fourth year after the first arrival of the Ngatitoa, nearly 2,000 warriors assembled between Otaki and Waikanae, consisting of Ngarauru, from Waitotara; the people of Patea, Wanganui, Wangaehu, Turakina and Rangitikei, the Rangitane of Manawatu, and the Ngatikahungunu, Ngatiapa, Ngatitumatakokiri, Rangitane and Ngatihuia, from the Middle Island. They were provided with ample means of transport, "the sea on the occasion of of their attack," to use the words of my informant, who was present on the occasion, "being covered with canoes, one wing reaching Kapiti from Otaki, whilst the other started almost simultaneously from Waikanae." The landing of the warriors composing the right wing was effected about four in the morning, but the alarm having already been given by the chief Nopera, who had discovered and notified their approach, the invaders were at once attacked by the Ngatitoa, of Rangatira, with great fury, whilst messengers were at the same time despatched to Taepiri, where Rauparaha lay with the bulk of his people, to inform him of the invasion. Before he could reach the scene of the conflict, however, the enemy had succeeded in pushing the Ngatitoa towards Waiorua, at the northern end of the Island. Pokaitara, who was in command, being desirous of gaining time in order to admit of the arrival of reinforcements, proposed a truce to the enemy, which was granted by Rangimairehau, a Ngatiapa chief, by whom they were led, who hoped, on his side, during the truce, to be able to land the rest of his forces, and then effectually to crush the Ngatitoa. Shortly after the truce had been agreed to,

Rauparaha and his warriors reached the scene of action, and at once renewed the battle with the utmost vigour; and, after a long and sanguinary conflict, completely defeated the invaders, with tremendous slaughter; not less than 170 dead bodies being left on the beach, whilst numbers were drowned in attempting to reach the canoes that were still at sea. The remainder of the invading force made their way, with all speed, to Waikanae and other points of the coast, where many of them landed, abandoning their canoes to the Ngatitoa, who had commenced an immediate pursuit. After the battle Rauparaha composed and sang a "song of triumph," the words of which I regret that I have not been able to obtain. The result was in every way advantageous to his people, for no further attempt was ever made to dislodge them, whilst they, on the other hand, lost no opportunity of strengthening their position and of wreaking vengeance on the Ngatiapa, Rangitane, and Muaupoko, the remnant of whom they ultimately reduced to the condition of the merest tributaries, many of the leading chiefs, including Te Hakeke, becoming slaves. It would be useless for me to give anything like a detailed account of the incursions of the Ngatitoa into the country on the main land, often extending as far as Turakina, in which numbers of the original inhabitants were killed and eaten, or reduced to slavery; but it is perfectly clear that their power was completely broken, and that after Waiorua, the Ngatitoa and their allies found no enemy capable of checking their movements. The news of the battle having reached Taranaki, with rumours of Rauparaha's astounding success, Te Puaha, with a detachment of Ngatiawa, came down to Kapiti in order to learn the truth of the matter, and having ascertained how completely Rauparaha had defeated his enemies, he returned to Taranaki for the purpose of bringing down a number of his people to join the Ngatitoa in their settlement of the country, as well as to take part in the prosecution of Rauparaha's further designs. Accordingly, he shortly afterwards brought with him, from Taranaki, a considerable number of fighting men, with their families, consisting partly of Ngatiawa proper, partly of Ngatihinetuhi, and partly of Ngatiwhakatere, being members of a *hapu* of Ngatiraukawa, who had escaped from a defeat on the Wanganui River, and had incorporated themselves with the Ngatiawa. This formed an important accession to the force under Rauparaha, which received further additions shortly afterwards from Te Ahu Karamu, a Ngatiraukawa chief of high rank, who, against the feeling of his people, had determined to join his great Ngatitoa kinsman. This chief, having heard from Rauparaha's emissaries of the difficulties in which he was likely to be placed by the defection of the Ngatiawa, had started from Taupo with 120 armed men, of his own immediate following, and arrived at Kapiti shortly after the battle of Waiorua, and then took part in many of the raids upon the original tribes which occurred after that event.

After remaining with Rauparaha for some months he returned to Taupo with part of his followers, where he reported the improved position of Ngatitoa, and urged his own section of the tribe to join them. Finding them still unwilling to do so, and being determined to effect his object, he ordered the whole of their houses and stores to be burned down, declaring it to be the will of the *atua* or spirit, angry at their refusal to obey the words of their chief. This being done the people gave way, and he took the necessary measures for the journey. In the meantime Whatanui and Te Heuheu had also determined to visit Rauparaha, in order to inspect the country he had conquered; the former chieftain intending, if it met his approval, to carry out his original design of joining the Ngatitoa in its occupation. In pursuance of this determination they, with a strong force of their own warriors, joined Te Ahu Karamu's party, the whole travelling down the Rangitikei River along the route followed by Te Ahu on his previous journey. During this journey they attacked and killed any of the original inhabitants whom they happened to fall in with. This migration is known amongst the Ngatiraukawa as the *heke whirinui*, owing to the fact that the *whiri*, or plaited collars of their mats, were made very large for the journey. Amongst the special events which occurred on the march was the capture of a Ngatiapa woman and two children, on the south side of the Rangitikei. The unfortunate children were sacrificed during the performance of a solemn religious rite; and the woman, though in the first instance saved by Te Heuheu, who wished to keep her as a slave, was killed and eaten by Tangaru, one of the Ngatiraukawa leaders. Shortly after this Ta Whiro, one of the greatest of the Ngatiapa chiefs, with two women, were taken prisoners, and the former was put to death with great ceremony and cruelty, as *utu* for the loss of some of Te Heuheu's people who had been killed by the Ngatiapa long before, but the women were spared. On the arrival of this *heke* at Kapiti, Te Heuheu and Whatanui held a long conference with the Ngatitoa chieftains, and Whatanui was at last persuaded to bring down his people. For this purpose he and Te Heuheu returned to Taupo, some of the party passing across the Manawatu Block, so as to strike the Rangitikei River inland, whilst the others travelled along the beach to the mouth of that river, intending to join the inland party some distance up. The inland party rested at Rangataua, where a female relative of Te Heuheu, named Reremai, famed for her extreme beauty, died of wounds inflicted upon her during the journey by a stray band of Ngatiapa. A great *tangi* was held over her remains, and Te Heuheu caused her head to be preserved, he himself calcining her brains and strewing the ashes over the land, which he declared to be for ever *tapu*. His people were joined by the party from the beach road at the junction of the Waituna with the Rangitikei, where the chief was presented with three Ngatiapa prisoners, who had been taken during the

ascent of the river. These were immediately sacrificed to the *manes* of Keremai, after which the whole body returned with all speed to Taupo. Before the return of Whatanui and his people to Kapiti, that place had been visited by some European whale ships, and Rauparaha at once traded with them for guns and ammunition, giving in exchange dressed flax and various kinds of fresh provisions, including potatoes. I may mention that until the arrival of the Ngatitoa the potato had been unknown in the Manawatu district, but at the time I now speak of it was extensively cultivated between that place and Taranaki, and formed one of the staple articles of food of the natives. He had no sooner obtained a supply of fire-arms and ammunition than he resolved to carry out his long-conceived intention of invading the Middle Island, a design in which he was greatly aided by the capture of the war canoes which had been abandoned by the allied forces after the battle of Waiorua; but, although he at once made preparations for carrying out his project, he postponed its actual execution until after the return of Whatanui. Shortly before the visit of the ships with which Rauparaha had carried on his trade, Te Pehi, observing one passing through Cook Strait, went out to her in a canoe, and, having managed to conceal himself until the canoe had left her, he succeeded ultimately in reaching England, his design being, like that of E Hongi, to obtain a supply of fire-arms and ammunition. His visit to England, where he was known under the name of Tupai Cupa, evidently a corruption of Te Pehi Kupe, is described in the volume for 1830 of "The Library of Entertaining Knowledge." We are enabled by means of this incident to fix the dates of some of the principal events in Rauparaha's career, for we know that it was in 1826 that Te Pehi managed to secrete himself on board the vessel above referred to.

Rauparaha's immediate designs were in the meantime somewhat interfered with by a rupture between a section of his people and the Ngatitama, under Puaha, some fighting taking place, which resulted in loss to both sides; but he at once peremptorily ordered peace to be made, an order which was obeyed by both sides. It seems that this dispute arose out of the occupation of some of the conquered land, which was claimed by both parties, and Waitohi, a sister of Rauparaha, foreseeing that constant disputes were likely to arise from the same cause, more especially when their numbers were increased by the expected arrival of the main body of the Ngatiraukawa, unless there was some definite arrangement as to the division of the country between them, suggested to Rauparaha that the Ngatiawa should all remove to Waikanae, and should occupy the land to the south of the Kukutawaki stream, whilst the country from the north bank of that stream as far as the Wangaehu should be given up to the Ngatiraukawa. This suggestion was adopted by all parties, and it was determined that the Ngatiraukawa, already

with Rauparaha, should at once proceed to occupy Ohau, then in the possession of the Ngatiawa. Having been assembled for this purpose they were escorted to their new location by Rauparaha and all the principal chiefs of Ngatitoa, travelling along the beach. On their way up they were feasted by Ngatirahira (a *hapu* of Ngatiawa) upon the flesh of black-fish, a large school of which had been driven ashore at low water, where the natives ingeniously tethered them by their tails with strong flax ropes, killing them as they were wanted for food. The Ngatiraukawa having been put into quiet possession of the houses and cultivations of the Ngatiawa, the latter removed to Waikanae, which continued for some time afterwards to be their principal settlement. The wisdom of Waitohi's suggestion above referred to is apparent from the fact that no further land disputes occurred between the several tribes until the fighting at Horowhenua many years afterwards, as will be related in the sequel.

Between this event and the date of Whatanui's return to Kapiti with the main body of his people, a *heke* composed of 140 fighting men with their families—called the *heke kariritahi,* from the circumstance that the warriors armed with muskets, had enlarged the touch-holes so as to be enabled (shrewd fellows as they were) to keep up a more rapid fire upon an enemy by saving the trouble of priming—came down from Maungatautari under the command of Taratoa. Whatanui accompanied this *heke* for the purpose of conferring with Rauparaha on matters of importance, but finding that the chief was absent, he at once returned to Taupo in order to bring down his people. The constant arrival of these armed bodies, and the manner in which they roamed over the Manawatu and Rangitikei districts, treating the remnant of the Ngatiapa and other original tribes with the greatest rigour, induced the latter to throw themselves upon the hospitality of the Ngatikahungunu at Wairarapa. In pursuance of this resolve, some 300 of them, including women and children, proceeded thither, but in consequence of a murder, followed by an act of cannibalism, which had been committed by some of the Rangitane upon a Ngatikahungunu man not long before, that tribe not only refused to receive the refugees, but attacked and drove them back with slaughter. The Ngatiapa then formally placed themselves at the mercy of Rangihaeata, whose connection, so frequently alluded to, with a chief of their tribe induced him to treat them with leniency, and they were accordingly permitted to live in peace, but in a state of complete subjection. The remnant of the Muaupoko, in like manner, sought the protection of Tuauaine, a chief of the Ngatiawa, who agreed to defend them against the long standing wrath of Rauparaha, but, as it appears, in vain; for it seems that having been informed by some of the Ngatiraukawa that these people were again settling at Papaitangi and Horowhenua, Rauparaha and Rangihaeata, with a war party of Ngatitoa and

Ngatiraukawa, proceeded thither and attacked them, killing many and taking a number of others prisoners, amongst whom was Toheriri, their chief. Toheriri's wife composed a lament on the occasion of the death of her husband, which is still recited amongst the Maoris. In this song she reflected on the broken promise of Tuauaine, who, though very sad at this slaughter, was entirely unable to prevent it. I merely mention this incident here, in order to show that lapse of time had in no degree weakened the revengeful feelings of Rauparaha, and that he considered the *manes* of his murdered children insufficiently appeased by the slaughter of the hundreds whom he had already sacrificed.

In about a year after the visit of Whatanui with Te Heuheu the former returned to Kapiti with the main body of his tribe, this migration being known as the *heke mairaro*, or "*heke* from below," the north point being always treated by the Maoris as downward. From that time forth for some years parties of the same tribe constantly recruited their countrymen in their settlements on the Manawatu, gradually extending their occupation over the whole country between Otaki and Rangitikei, although their chief stations were in the Horowhenua and Ohau districts; whilst the Ngatiapa, under the protection of Rangihaeata and Taratoa, occupied some country on the north of the Rangitikei, yielding tribute to both of these chiefs as a condition of their being left in peace.

Not long after the arrival of Whatanui with the *heke mairaro*, Rauparaha put in execution his long meditated project of invading and permanently occupying the northern coasts of the Middle Island. It appears that his fame as a warrior had reached the ears of Rerewhaka, a great chief of the Ngaitahu, whose principal settlement was at the Kaikoura Peninsula. This chief had been excessively indignant at the defeat of the allies at Waiorua, and on hearing of the song of triumph, chanted by Rauparaha on that occasion, in which the latter indicated his intention of attacking and subduing the Ngaitahu, he had declared "that if Rauparaha dared to set a foot in his country he would rip his belly with a *niho-manga*, or shark's tooth," a curse which was reported to Rauparaha by a run-away slave, and which—his memory for small matters being remarkably tenacious—would afford him, at any distance of time, ample pretext and indeed justification for attacking Rerewhaka and his people. In 1828, having accumulated a considerable quantity of fire-arms and ammunition, he started with 340 picked warriors, comprising Ngatitoa, Ngatiawa, Ngatitama, and Ngatiraukawa, under Niho, the son of Te Pehi, Takerei, Te Kanae, Te Koihua, Te Puoho, and other chiefs of note, and first made for D'Urville Island, at the north-east head of Blind Bay. At this time D'Urville Island, the Pelorus and Queen Charlotte Sounds, the Wairau and the Awatere, were all occupied by a numerous section

of the Rangitane tribe, which had settled in these places after destroying the Ngatimamoe some 200 years before. But though numerous, and in that sense powerful, so long as their warfare was carried on with the ordinary New Zealand weapons, they were no match for the chosen warriors of Te Rauparaha, more particularly when armed with the more deadly European weapons. The consequence was that they were everywhere disastrously defeated, hundreds of them being killed and devoured on the spot, whilst numbers of the prisoners were taken to Kapiti to undergo the same fate, the wretched remnant being kept in abject slavery by such of their conquerors as settled in the newly acquired district.

Whilst Rauparaha was engaged in these operations Te Pehi returned from England, and at once joined him with a considerable number of followers. Shortly after this the main force divided, a subdivision of the Ngatitoa named the Ngatirarua *hapu*, under Niho and Takerei, the Puketapu and Nutiwai *hapus* of Ngatiawa, under Te Koihua, and the Ngatitama, under Te Puoho, proceeding to Blind and Massacre Bays—and whose exploits will be hereafter referred to—whilst Rauparaha, Te Pehi, and other chiefs, with 300 well armed men, flushed with victory, and grown strong upon human flesh, left Rangitoto for the Kaikoura Peninsula, in order to afford to Rerewhaka the opportunity of putting his long made threat into execution. But the Ngatitoa chief felt sure of a comparatively easy victory, for notwithstanding a great numerical superiority on the part of the enemy, he knew that they were indifferently, if at all, supplied with fire-arms, whilst the great bulk of his own men were well furnished with guns, powder, and ball. It will be observed that, in accordance with the well known habit of the New Zealanders, Rauparaha had never forgotten Rerewhaka's curse, and he felt highly elated at the prospect of a revenge, which the force at his command rendered almost certain. But besides this prospect of vengeance, and the anticipated additional gratification of devouring the bodies of the slain, he expected to acquire large quantities of green-stone weapons and ornaments, in which, as he had been informed by the slave who had reported Rerewhaka's foolish boast, the Ngaitahu of the Kaikoura and Amuri were especially rich, for notwithstanding the introduction of fire-arms into their system of warfare, the *mere pounamu*, or green-stone battle-axe, and other implements of war manufactured from that substance, was then, and indeed always has been, held in great estimation by the Maoris. Rauparaha, therefore, longed to add the acquisition of such treasures to the gratification which he would derive from wreaking vengeance upon the Ngaitahu chieftain, for the insult under which he had so long suffered.

As my readers are probably aware, the green-stone or nephrite, from which the more valuable of the weapons in question are made, is found

exclusively on the West Coast of the Middle Island, and it appears that the Ngaitahu of Kaikoura and Amuri especially, had long been in the habit of sending war parties across the island, for the purpose of killing and plundering the inhabitants of the district in which it was obtained. These expeditions sometimes passed through the Tarndale country to the Upper Waiauua, and from thence through the Kopiokaitangata, or Cannibal Gorge, at the head of the Marina River, into the valley of the Grey, from whence they ran down the coast to the main settlements from the mouth of that river to Jackson Bay, and at other times passed from the Conway and other points on the East Coast through the Hanmer Plains to the valley of the Ahaura, a tributary of the Grey, and so to the same localities. The line of route by the Cannibal Gorge runs partly through a tract of country which I now occupy as a cattle-run, and my men have frequently found stone axes, pawa shells, remains of eel-baskets, and other articles, left on the line of march; similar articles being also found on the line through the Hanmer Plains. The scenery of the upper country on the line by the Cannibal Gorge is very grand and beautiful, the valley of the Ada, the head waters of which rise within half a mile of those of the Marina, running through an immense cleft in the Spencer Mountains, the summits of Mount Una and the Fairy Queen, capped with perpetual snow, rising abruptly on each side of the stream, to a height little under 6,000 feet, whilst the valley itself is rarely more than a quarter of a mile in breadth. The Cannibal Gorge is extremely rugged, and the fall of the river tremendous, its waters, when swollen by rain and melting snow, pouring down the gorge for miles in a perfect cataract of foam, and with a roar, which, echoed from the rocky glens on each side, rivals that of Niagara. During their journeys to the coast through these rugged scenes the war parties lived entirely on eels, wekas, and kakapos, which, at that time, were numerous in the ranges; whilst on their return, after a successful raid, human flesh was often carried by the slaves they had taken, and the latter were, not unfrequently, killed in order to afford a banquet to their captors. During these expeditions large quantities of green-stone, both in rough blocks and in well-fashioned weapons—an art especially known to the West Coast natives—were often obtained, if the approach of the invaders was not discovered in time to permit the inhabitants to conceal themselves and their treasures, and it was the accumulated wealth of many years which Rauparaha expected to acquire in case he should prove victorious in his projected attack upon Rerewhaka and his people.

CHAPTER VI.

IT was not until the morning of the fourth day after leaving D'Urville Island that the war party reached the Kaikoura Peninsula, and as they had

arrived before daylight they anchored a short distance from the shore, in order that they might be enabled at dawn to reconnoitre the position of the enemy before landing. It would appear that the Ngaitahus at that time expected a visit from a southern chief of their own tribe, with a considerable following, and that on the morning in question, seeing the canoes of Rauparaha's party at anchor, and not having noticed the direction from which they had come, they mistook them for those of their friends, and large numbers of the people of the pa ran down to the shore, shouting the cry of welcome to the supposed visitors, who, at once seeing the advantage which the mistake would afford them in their intended attack, made for the shore with all possible speed, and having reached it jumped out of the canoes and immediately commenced the attack. The unfortunate people, being quite unarmed, and taken by surprise, endeavoured to escape by retreating towards the pa, which, in the general confusion, was taken without difficulty, some 1,400 of the people, including women and children, being killed or taken prisoners, amongst the latter of whom was the chief Rerewhaka, whose threat Rauparaha was then avenging. After remaining for some time to feast upon the bodies of the slain, and to plunder the pa of its treasures, the victorious Ngatitoa returned with their prisoners to Kapiti, where the greater number of the latter, including Rerewhaka himself, were put to death and eaten, the chief having been sacrificed with great cruelty on account of the threat which had been the prime cause of the attack. In consequence of this circumstance Rauparaha named the battle the "*niho manga*, or battle of the shark's tooth." At the time of this event another section of the Ngaitahu tribe occupied an extensive pa called Kaiapoi, about fourteen miles north of Christchurch, with the inhabitants of which Rauparaha made up his mind to pick a quarrel at the first convenient opportunity, but he felt that the force he had under his command at Kaikoura was too small for the purpose of any attack upon it, particularly after the enemy had received notice of the fall of the latter place, and had had time to make preparations for defence. In the following year, before he had had an opportunity of devising any particular scheme for the purpose of bringing about a quarrel between himself and the Kaiapoi people, he was induced again to attack the remnant of the Ngaitahu at Kaikoura, in consequence of an insult put upon Rangihaeata by a Ngatikahungunu chief named Kekerengu, who, dreading the consequences, had fled across the strait and taken refuge with them. Rauparaha collected a considerable force of Ngatitoa and their allies, under his own leadership, with Te Pehi, Pohaitara, Rangihaeata, and other principal chiefs under him, and started for the Wairau, from whence he made his way along the coast to Kaikoura. On his arrival there he found that the pa had been evacuated on their approach, the inhabitants flying down the Amuri. They were overtaken

by the war party at a pa called Omihi, where they were attacked and routed with great slaughter, numbers of prisoners being also taken. These were left in charge of a detachment, whilst the rest of the force pushed with all speed for Kaiapoi, in order that Rauparaha might put his design against its inhabitants into execution. The pa of that name was situated just within the line of the coast dunes of Pegasus Bay, about a mile to the south of the River Ashley, and was erected upon a promontory about nine or ten acres in extent, which extends into a deep swamp lying between the sand dunes and the bank of the river. This swamp, which is very deep, nearly surrounds the site of the pa, and prevented it from being attacked at any point except in front; and along the line of the front, extending from one branch of the swamp to the other, a distance of about 250 yards, it was defended by a double line of heavy palisading and a deep ditch, with two large outworks, from which a flank fire could be maintained on any party attempting to scale the palisades. I have frequently visited the site of this pa, which still exhibits unmistakeable evidences of the conflict which took place there, including many relics of the special festivities with which the Maoris invariably celebrated their victories. I was informed that after its fall (which will shortly be fully detailed) the principal defenders threw large numbers of their choicest green-stone weapons and ornaments into the deepest part of the swamp, where they still lie, to reward any enterprising person who will drain it for the purpose of recovering them.

When Rauparaha and his people arrived at the pa, they at once opened intercourse with the chiefs, pretending that they had come to seek their friendship, and desired to barter fire-arms and ammunition in exchange for green-stone, in which the people of Kaiapoi, like their kinsfolk at Kaikoura, were extremely rich, but the latter, having been informed by some refugees of the slaughter at Omihi, distrusted the good intentions of their visitors. In order, however, to remove all pretext for hostilities they received them with great appearance of cordiality, and treated the chiefs who visited their houses with ostentatious hospitality. Rauparaha himself, however, could not be induced to enter the pa, the wily chief feeling that he had too surely earned their animosity by the slaughter of their kinsfolk, and, therefore, could not justly place much trust upon their professions of friendship. It appears, according to the Ngatitoa account of the affair, that Te Pehi, who in order to keep up the deception had carried on a trade with some of the people, let the cat out of the bag; for a Ngaitahu chief having expressed great unwillingness to part with a coveted green-stone weapon, was told by Te Pehi, in anger, "Why do you, with the crooked tatoo, resist my wishes; you, whose nose will shortly be cut off with a hatchet." This confirmation from the lips of one of the chiefs in command of the Ngatitoa of their preconception of

the real designs of Rauparaha's party, determined the people in the pa to strike a blow which would prevent Rauparaha from further prosecuting his design, at least at that time; and, for this purpose, they resolved to kill the chiefs then in the pa, amongst whom, besides Te Pehi, were Pokaitara, Te Aratangata, of Ngatiraukawa, and others of note. Pokaitara had taken to wife from amongst the prisoners at Kaikoura the daughter of Rongatara, one of the Ngaitahu chieftains then in the pa, and having been invited to the house of the latter under pretext of receiving a present of green-stone, proceeded thither without suspicion of foul play. As he stooped to enter the house the old chief, Rongatara, took hold of his mat, saying, "Welcome, welcome, my daughter's lord," at the same time killing him by a blow on the head with the green-stone club which he expected to have received as a gift. The death of Pokaitara was the signal for a general slaughter of the Ngatitoa chiefs, who were at once despatched, their bodies being destined to the *umus* of their murderers. The slaughter of his uncle, and of so many of his leading chiefs, was a severe blow to Rauparaha, who, with the rest of his party, at once fell back on Omihi, where he re-united his forces. In part revenge for the murder, he at once slew all the prisoners, and, after devouring their bodies, returned to the Wairau, from whence they crossed over to Kapiti. The Ngaitahu account of the origin of the quarrel is different, and I give it from a petition presented, in 1869, to the House of Representatives, by Patterson, then Maori member for the Southern Maori Electoral District. The petition refers to a letter addressed to Patterson by the *runanga*, or local council, of the Maoris living near the European village of Kaiapoi, which is situated on the banks of the Waimakariri River, some miles north of the pa above referred to. The following is the text of the letter, which I give nearly entire, as being of much interest in connection with my story:—

"To Patterson,—

"O friend, salutations to you, and to the Assembly, that is to say, the great chiefs who work for justice and truth.

"O sir, this is the matter which we submit to you, do you publish it to the Assembly, so that the great doctors may examine this disease. The disease is the sale by Ngatitoa of this land.

"After you had left, the *runanga* gave their attention to the question of the affliction under which they are suffering, and now it is submitted to the great doctor to be prescribed for by him. Had the defeat of the people at this land been equal to that of the people of Rangitikei and Manawatu by Te Rauparaha and Ngatiraukawa, where the people were killed and the land was taken possession of, and has been kept up to this time, then it would have been right that we should suffer under this affliction. But, as for the defeat of the natives of Kaiapoi, the Maori *runanga* consider that it is very clear

that the battles in which the Kaiapoi natives were defeated were not followed up by occupation on the part of the victors. According to our view the killing of the Kaiapoi natives was caused by the Rangitane, who said that Te Rauparaha was to be killed with a stick used for beating fern-root. He then attacked the Rangitane, and defeated them. When Rerewhaka heard that his relatives had been slain, he said that he would rip Te Rauparaha's belly up with the tooth of a barracoota; it was through that that this evil visited this place. Rerewhaka was living amongst the people of Kaiapoi when he said that. Te Rauparaha should have killed that man, for he was the cause of the crime; he spared him, but killed the descendants of Tuteahuka. O friends, the men of Kaiapoi were in deep distress on account of the killing of their relatives at Kaikoura and at Omihi. Now these two pas were destroyed by Te Rauparaha; then Ngatituteahuka and Ngatihikawaikura, the people of Kaiapoi, bewailed their defeat. Te Rauparaha should have borne in mind that the flesh of our relatives was still sticking to his teeth, and he should have gone away and left it to us to seek payment for our dead after him, but he did not, he came to Kaiapoi. When he came the old chiefs of Kaiapoi wished to make peace, and sent Tamaiharanui to Te Rauparaha. On their meeting they made peace, and the talk of Tamaiharanui and Te Pehi was good. After Tamaiharanui had started to come back Te Rauparaha went to another pa of ours, called Tuahiwi, and there sought for the grandmother of Tamaiharanui. They dug her body up and ate it, all decomposed as it was. Tamaiharanui was greatly distressed, and threatened to kill the war party of Te Rauparaha. Then his elder relatives, the great chiefs of Kaiapoi, said to him, 'O son, do not, lest further evil follow in your footsteps.' He replied, 'It would not have mattered had I been away when this decomposed body was eaten, but, as it is, it has taken place in my very presence.' Well, as the chief gave the word, Te Pehi, a great chief of Ngatitoa, and others were killed. Then Te-Rauparaha went away."

Such is the Ngaitahu account of the origin of the quarrel, which I am inclined to accept. It will be thought strange that Te Rauparaha did not, without seeking any pretence for the act, attack the pa in force, but to have done so would have been a violation of the Maori etiquette in matters relating to war. He had taken vengeance for the threat of Rerewhaka, and it was for the relatives of the latter to strike the next blow, which it appears they were unwilling to do, dreading the very results which afterwards followed in revenge for the killing of Te Pehi.

Rauparaha brooded much over this murder of his relative, who, having accepted a secondary position in the tribe, no longer excited his jealousy, and had greatly assisted him as a wise counsellor and valiant leader. After full consultation with the other chiefs of the tribe, he resolved that his revenge

should be carried out by an act as treacherous as that by which the death of Te Pehi and his companions had been brought about; and whilst still revolving in his mind the best means of accomplishing this design, an European vessel arrived at Kapiti from Sydney, after having passed through Foveaux Strait and visited the Auckland Islands for the purpose of leaving a party of sealers at the latter place. Amongst the passengers by this vessel was Hohepa Tamaihengia (who lately died at Porirua), a near relative of Rauparaha, who, on reaching Foveaux Strait, had heard of the murder of Te Pehi and his companions from the Maoris there. Hohepa himself at once conceived the project of seizing and killing some of the Ngaitahu chiefs in *utu* for their death, and entered into arrangements with the master of the vessel to proceed to Akaroa for that purpose. This plan, however, having become known to some European passengers who were about to join a whaling party in Queen Charlotte Sound, they dissuaded the master from carrying it into effect, and the vessel proceeded direct to Kapiti. Hohepa communicated his design to Rauparaha, who determined to follow it out on the first convenient opportunity. Sometime after the departure of this vessel, the English brig "Elizabeth" arrived at Kapiti. This vessel was commanded by a person named Stewart, to whom Rauparaha offered a large cargo of flax if he would carry him and a chosen party of warriors to Akaroa, for the purpose of seizing Tamaiharanui, the principal chief of the Ngaitahu, who had been present at Kaiapoi, at the time of the murder of Te Pehi, and had indeed taken an active part in counselling it.

Stewart assented to the proposal, and conveyed Rauparaha and his warriors to Akaroa, where the European scoundrel, at the instigation of his charterer, opened communication with the unsuspecting Tamaiharanui, and ultimately induced him, with his wife and daughter, by the promise of some guns and powder, to come on board, where he was at once seized by Rauparaha, who, with his men, had up to this time remained concealed in the hold of the vessel. Having bound the captured chief they remained quiet until nightfall, and then, landing in the ship's boats, attacked the Ngaitahu in their village, of whom they killed large numbers. The bodies of the slain were taken on board the vessel, which at once set sail for Kapiti. On the passage up the successful *taua* feasted on these bodies, using the ship's coppers for cooking them. It may be that when Stewart engaged his vessel for this expedition he was not made aware of the intentions of Te Rauparaha, or did not foresee the results which followed, whilst he was certainly unable to prevent the atrocities which were perpetrated on board of her, but his name will always be infamous for his connection with this atrocious affair. It appears that the unfortunate Tamaiharanui attempted to commit suicide, in consequence of which he was chained in the cabin, but his hands being free,

he managed to strangle his daughter, and to push her body through one of the after ports, in order to save her from the indignities to which she would be subjected by her ruthless captors, but he himself was taken alive to Kapiti, where he was delivered over to the widows of Te Pehi, who subjected him to frightful tortures, until at length he was put out of his misery by a red-hot ramrod being passed through his neck.

The following is the account given to me by Tamihana Te Rauparaha of the mode in which the unfortunate chief was delivered over to his death :—"When the vessel arrived at Kapiti it was proclaimed that Tamaiharanui was on board, and the people were delighted. Ngaitahu had thought there was only the flowing sea (*i.e.*, that there was no one going to attack them), but they were deceived, and Tamaiharanui was taken. There were not many people left in charge of Kapiti when the ship returned; they were at Waikanae and Otaki scraping flax as cargo for the vessel. Te Pehi's widows were at Waitohu, near Otaki, scraping flax. Tamaiharanui was then taken to Otaki in Rauparaha's canoe to be shown to those widows, as it was to be left to them to determine whether he was to be killed or allowed to live. When they arrived at Otaki he asked Rauparaha to spare him, but Rauparaha replied, 'If the party killed, that is, Te Pehi, belonged to me, I would save you, but as the dead belonged to Ngatitoa I cannot save you.' He was then taken to Waitohu, to be seen by the widows, and by Tiaia, the chief wife of Pehi, and was then delivered over to them. They hung him on a tree and killed him with great torture, and he died when a red-hot ramrod was put through his neck by Tiaia. Rauparaha did not witness his death."

It is impossible to conceive that women could descend so low in the scale of humanity as to commit such atrocities without any sentiment of compassion or of remorse, but those who are familiar with the history of the times of which I write, may recall many frightful instances of barbarity of the same kind. Amongst these, one of the most cruel which has come under my notice is the following, related by Mr. Wilson in his "Three chapters in the Life of Te Wakaroa":—"We may here mention a tragedy—all are tragedies in this chapter of horrors. Mr. Knight was accustomed, every morning about sunrise, to attend a school at Ohinemutu Pa, but as there were no scholars on the morning of the 12th May, he went to the place where he was told they would be found. There he perceived a great number of people sitting in two assemblages on the ground—one entirely of men, the other of women and the chief Pango. The former company he joined, and conversed with them, as well as he was able, on the sin of cannibalism, but Korokai and all laughed at the idea of burying their enemies. Their conversation ceased, however, on Knight hearing the word *patua* (kill) repeated several times; and looking round toward the women, he was horrified to see

the widow of the late chief Haupapa, who had been killed at Maketu, standing naked and armed with a tomahawk, whilst another woman, also nude, and Pango were dragging a woman taken prisoner at Te Tumu, that she might be killed by Mrs. Haupapa, in the open space between the men and the women. Mr. Knight immediately sprang forward, and entreated them not to hurt the woman, but Mrs. Haupapa, paying no attention, raised her hatchet; on this, Knight caught the weapon and pulled it out of her hand, whereupon the other woman angrily wrenched it from his grasp, and would have killed him had not Pango interposed by running at him and giving him a blow and thrust that nearly sent him into the lake. He was, however, about to return when the natives seized him and held him back. Just then, the poor woman slipping out of the garments she was held by, rushed to Knight, and falling down, clasped his knees convulsively, in an agony of terror. Her murderers came, and abusing the *pakeha* the while for *pokanoa-ing* (interfering or meddling), with difficulty dragged her from her hold. The helpless *pakeha* says, 'It would have melted the heart of a stone' to hear her calling each relative by name, beseeching them to save her, for though a Tauranga woman, she was connected with Rotorua, and to see her last despairing, supplicating look, as she was taken a few yards off and killed by that virago Mrs. Haupapa. Now this scene occurred simply because Haupapa's widow longed to assuage the sorrow of her bereaved heart, by despatching, with her own hand, some prisoner of rank as *utu* for her lord. The tribe respected her desire; they assembled to witness the spectacle, and furnished a victim by handing over a chief's widow to her will."

It may, as I have before observed, seem strange that Rauparaha did not at once take the bolder and more manly course of attacking the Ngaitahu at Kaiapoi, in the ordinary way of warfare, for the purpose of avenging the murder of Te Pehi and his brother chiefs, but I am informed by his son that the course he adopted was strictly *tika*, or, in other words, in accordance with Maori etiquette in such matters, and that, indeed, any other line of action would not properly have met the exigencies of the case. That Rauparaha was not limited to the adoption of what we should consider the treacherous plan of revenge above related is clear from the events which I am about to refer to, for in about a year after the capture of Tamaiharanui our chief determined, in furtherance of his original design, to attack the great pa at Kaiapoi. For this purpose he assembled a large force, comprising Ngatitoa, Ngatiawa, and Ngatiraukawa, part of whom made their way through the Wairau Gorge and the Hanmer Plains to the Waipara River, which flows into the sea near the north head of Pegasus Bay; whilst he, with the main body of his forces, passed over to the East Coast, through the country now occupied by Messrs. Clifford and Weld, and from thence down that coast to the mouth of the

Waipara, where they were joined by the inland party. The inland line of march runs through some of the most picturesque country in New Zealand, the gorge of the Wairau, especially, being rugged and grand in the extreme. I was the first European who ever passed through this gorge, which I did in 1859 or 1860 for the purpose of determining whether it would afford a practicable line of communication between Nelson and Canterbury, and on that occasion I was accompanied by a Ngatitoa man, who had been one of the inland war party on the occasion above referred to. Singular to state, however, I found, after passing through the gorge, that he had entirely forgotten the line of route between Tarndale and the pass into the Hanmer Plains, and the season was, unfortunately, too far advanced to permit of my attempting to discover it independently. Indeed, my party was snowed up for several days, and as we ran some risk of getting short of food for the return journey, I was reluctantly compelled to give up the design. This was, however, of little importance, as Mr. Weld, now Governor of Western Australia, had, a few days before my passage through the upper part of the gorge, found his way into Tarndale over the mount near the junction of the Wairau and Kopiouenuku Rivers, and had established the connections between that place and the pass known as Jollie's Pass, leading from the Clarence River into the Hanmer Plains. Subsequent explorations of my own resulted in the discovery of the country in the Upper Waiauua and the line of the Cannibal Gorge, and of a shorter and easier pass from Tarndale into the Hanmer Plains, being probably the one used by the native party above referred to.

After the junction of the two bodies Rauparaha proceeded at once to Kaiapoi for the purpose of attacking the pa. The Ngaitahu were evidently quite unprepared for this fresh invasion, a large number of their warriors being absent at Port Cooper, whither they had accompanied Taiaroa (father of the present member of the House of Representatives of that name), who was then the leading chief of that portion of their tribe which occupied the country in the neighbourhood of the present site of Dunedin, and who was returning home after a visit to his kinsfolk at Kaiapoi. Others of the people were engaged in their cultivations outside of the pa, which was, in fact, only occupied by a small number of able-bodied warriors and a few of the older men, and some women and children. So carefully had Rauparaha concealed the approach of his war party that the first intimation which the inhabitants of the pa received of it was the sound of the firing as his force attacked the people in the cultivations, and the cries of the dying and wounded; and they had barely time to close the gates of the outworks and to man the line of defences before a number of the enemy appeared in front of it. The Ngatitoa at once sprung to the assault, hoping to carry the defences by a *coup de main*,

but were repulsed with some slaughter; and after renewing the attempt and finding them too strong to be thus overcome, they determined to commence a regular siege. For that purpose they intrenched themselves on the ground in front of the pa, at the same time occupying some sand-hills which commanded it on the eastern side, but from which it is separated by a branch of the great swamp before referred to. In the meantime, some of the Ngaitahu who had escaped from the first attack, favoured in so doing by their intimate knowledge of the line of swamps which occupies the intervals between the sand-dunes and the sea coast as far as Banks Peninsula, managed to reach Port Cooper, where they informed their people of the attack upon the pa, arriving there in time to stop Taiaroa and those who were about to accompany him to Otago. After collecting reinforcements from the villages on the peninsula, Taiaroa and his forces made their way along the coast line as far as the Waimakariri, availing themselves of the swamps above referred to, for the purpose of concealing their march from any detached parties of the Ngatitoa. On reaching the Waimakariri they crossed it on rafts (commonly called *mokihi* by the natives) made of dried stalks of the *Phormium tenax,* and concealed themselves until dark. Finding the hostile forces encamped along the front of the pa, and warned by their watch-fires that they were on the alert, they determined to ford the swamp at a narrow point on its western side, and to enter it through an outwork erected there, that being the only point along the line of the swamp which was at all weak. Using the utmost caution in their approach to this point they succeeded in reaching it without having attracted the notice of the besiegers, and at once plunged into the swamp, trusting to be able to struggle through it and to enter the pa without being attacked by the Ngatitoa. Knowing, however, that the defenders would also be on the alert, they shouted the name of Taiaroa as they plunged into the water, in the hope that their friends would recognise their voices and take the necessary steps to admit them; but the latter, believing it to be a ruse of the Ngatitoa, opened fire upon them, which was kept up vigorously for some time. The error having at last been discovered, and little damage having fortunately been done, the main body of the warriors were admitted into the pa, to the great joy of the handful of people by whom, up to that time, the defence had been maintained. The siege operations were, however, in but a slight degree affected by this accession of strength to the besieged, for although they made frequent sorties against the works of the Ngatitoa these experienced warriors held them without difficulty, and repulsed them all with loss to the assailants. The Ngaitahu, dispirited by their failures, soon abandoned these tactics, and, trusting in the impregnable nature of the pa, confined themselves to purely defensive operations. I ought to mention that at the time the siege commenced the pa was well provisioned, besides which

the lagoon yielded large supplies of eels, so that the defenders ran little risk of being obliged to surrender on account of famine, whilst the besiegers, on the other hand, were compelled to depend on foraging parties for supplies, and frequently ran short of provisions. Indeed, the difficulty of feeding his men was the chief cause which led to the adoption of a plan of attack which, so far as I am aware, was then adopted for the first time in Maori warfare. A council of war having been held, it was determined to sap up to the two outworks, and as soon as the head of the sap had been carried up to them, to pile up in front of them immense quantities of dried brushwood, which were to be set on fire when the wind blew in the direction of the pa, and to rush it so soon as the palisading had been burned down. This plan was carried out, and the two lines of sap exist to this day, and are as well carried out as if done by the most experienced European engineers. At first Rauparaha suffered considerable loss, for the enemy, foreseeing that the pa must be taken if this plan of operation was successfully carried out, made the most strenuous efforts to prevent it, but having been defeated in every encounter, and Rauparaha having taken precautions to prevent future loss, they allowed the saps to be pushed close up to the outworks. So soon as the besiegers, however, had piled the brushwood in position it was fired by the people of the pa, the wind at the time blowing from the north-west; but a sudden change occurring, both the outworks, as well as the general line of defences, were soon enveloped in a mass of flame and smoke, from which the defenders were compelled to retreat. When the palisading had thus been destroyed, the Ngatitoa rushed through the burning ruins, and a general massacre ensued. Many endeavoured to escape by swimming across the lagoon, and some few succeeded in doing so, whilst others were interrupted by bodies of Ngatitoa detached for that purpose. The slaughter was tremendous, whilst numbers of prisoners also fell into the hands of the victors. Some conception may be formed of the numbers slain and eaten, when I mention that some time after the settlement of Canterbury the Rev. Mr. Raven, Incumbent of Woodend near the site of the pa in question, collected many cartloads of their bones, and buried them in a mound on the side of the main road from the present town of Kaiapoi to the north. Ghastly relics of these feasts still strew the same ground, from which I myself have gathered many.

Having thus captured the main stronghold of the Ngaitahu, Rauparaha sent detached parties of his warriors to scour the plains as far south as the Rakaia, as well as to ravage the villages on the peninsula, by whom hundreds of the unfortunate people were slaughtered; after which he made his way back to the shores of Cook Strait, and from thence to Kapiti, laden with spoil, and accompanied by large numbers of captives, some of whom were kept in slavery, whilst others were used in the ordinary manner in the festivities by which his triumph was celebrated.

Chapter VII.

Rauparaha having thus completed his design of conquering the Middle Island, next turned his attention, at the earnest request of the Ngatiraukawa, to avenging a defeat which the latter had sustained some time previously at the hands of the tribes occupying the line of the Wanganui River. In this defeat only a few of the chiefs had escaped the general slaughter, amongst whom were Te Puke and his younger brother Te Ao, both of whom succeeded in making their way to Kapiti. In consequence of this resolution, a war party numbering nearly a thousand fighting men, under the most distinguished chiefs of the three tribes then united under the general leadership of Rauparaha, was despatched to lay siege to Putikiwaranui, a great pa of the Wanganuis, which was occupied and defended by nearly double the number of the attacking force. The siege lasted upwards of two months, during which many sorties were made, but the besiegers maintained their ground, and ultimately carried the enemy's works by assault, slaughtering an immense number of them. Turoa and Hori Te Anaua (lately known as Hori Kingi) the head chiefs, however, escaped, but the fact that no attempt was even made to avenge this serious disaster, is of itself the strongest evidence of the power of Te Rauparaha and his allies, and of the absurdity of supposing that his occupation of the country he had conquered could for a moment have been disturbed by the remnant of the Ngatiapa, Rangitane, and Muaupoko tribes which had still escaped the general destruction of their people. Soon after the year 1835, the great body of the Ngatiawa, under the chiefs E Puni, Warepouri, Wi Tako, and others, and accompanied by numbers of the Taranaki and Ngatiruanui tribes, came down the coast, many of them settling around and to the southward of Waikanae, whilst others took possession of Port Nicholson and the Hutt country, from which they drove the section of the Ngatikahungunu, which up to this time had occupied those districts. This migration took place after the destruction of the great Ngatiawa pa of Pukerangiora, inland of the Waitara.

It appears that many years before this event the Waikato tribes, under Te Wherowhero and Taiporutu (father of Waharoa and grandfather of William Thompson Tarapipi, so celebrated in connection with our own Waikato wars) had suffered severely at the hands of the Ngatitama under the leadership of Kaeaea, by whom Taiporutu was crucified in the gateway of a pa defended by this ruthless warrior. It was indeed from this circumstance that Waharoa took his name, which signifies the large gateway of a pa. This defeat, as well as that which they had suffered at the hands of Te Rauparaha and his allies, during the migration of the Ngatitoa from Kawhia, naturally rankled in their minds, and in one of the intervals of the wars of Te Waharoa against the Ngatimaru, he and Te Wherowhero concerted a campaign against the Ngatiawa. There is

little doubt, however, that but for the great superiority in the weapons of the Waikato force, they would have thought twice before attacking their old foes, who had always been notorious for their bravery, and who in their frequent migrations had proved themselves more than a match for even the most warlike tribes to which they became opposed. But the possession of a large supply of fire-arms gave to the Waikato chieftains an almost irresistible offensive power, and they did not hesitate, therefore, in attacking the Ngatiawa, even in the midst of their own country and in their principal stronghold. The pa was defended by a large number of warriors, and withstood for many months the most vigorous assaults, only falling at last after the unfortunate inhabitants had suffered much from famine. When taken, hundreds of prisoners fell into the hands of the victors, and it is related of Te Wherowhero that upwards of 250 of them were slain with his own hands, in order that they might be prepared for the ovens. It is said that, as he sat on the ground after the assault, the unfortunate wretches were one by one placed alongside of him, their heads within his reach, and that he despatched them succesively by a single blow on the skull with a celebrated *mere pounamu*, now in the possession of his son, the present Maori King. After killing this great number he threw the *mere* down, exclaiming, "I am tired, let the rest live," and accordingly their lives were spared, but they were kept in slavery until some time after the establishment of the European settlement of New Plymouth.

The heavy blow thus inflicted upon the tribe, and the fear of complete annihilation, determined those who still remained to join Rauparaha and the Ngatiraukawa, whose forces, thus increased, would be more than a match for any war party which the Waikatos could bring against them, even if the chiefs of the latter tribes felt disposed to carry hostilities into Rauparaha's country. It appears that, shortly after the arrival of the Ngatiawa on the coast, they formed the design of taking possession of a large part of the country occupied by the Ngatiraukawa, and particularly that in the neighbourhood and to the north of Otaki. It would seem, moreover, that there was dissension amongst the Ngatitoas themselves, a portion of them taking part with the Ngatiawa, out of jealousy at some apparent favouritism extended by Rauparaha to the great Ngatiawa chieftains, and more particularly to Whatanui, whose relationship to Rauparaha, together with his high character as a chief and warrior, gave him great influence with the latter. The immediate cause of the fighting to which I am about to refer, however, was a robbery committed by a party of Ngatiruanui, who were caught by the Ngatiraukawa in the very act of plundering their potato pits near Waikawa. A conflict at once took place, in which a leading chief of the Ngatiruanui, named Tawhake, was killed, and this led to hostilities being carried on between the two tribes at various

points on the line of their settlements between Manawatu and Waikanae. This state of affairs continued for a considerable time, the forces engaged on each side being numerous and well armed, the result being that large numbers were killed on both sides. Soon after this civil war had commenced Te Rauparaha, who at once saw the disastrous results which must follow from it, sent messengers to Te Heuheu, urging that chief to bring down a force sufficiently strong to enable him to crush the Ngatiruanui, who were the most turbulent of the insurgents, after which he hoped to be able to bring about a peace between the remainder of the contending parties. He was much grieved, moreover, at the dissension in his own tribe, part of which, as I have before mentioned, had joined the Ngatiawa leaders, and had taken an active part in the numerous engagements which had already occurred. The loss on both sides had been severe, and Rauparaha knew full well that he required the whole strength at his command to maintain his position against the Wanganui and Ngatikahungunu tribes, who would have been but too ready to attack him if they saw any reasonable prospect of success. In this connection, I may observe that at this period the shores of Cook Strait were frequented by numbers of whale and other ships, and the tribes along the coasts found no difficulty in obtaining fire-arms and ammunition, which were the principal articles received in barter for flax, then largely used in Australia for the manufacture of wool-lashing. This facility of obtaining European weapons placed the tribes in question upon a footing of comparative equality in their contests, and Rauparaha could no longer reckon upon a continuance of the advantages which his own earlier possession of them had given him in his wars, and it was, therefore, of the utmost moment to him that nothing should take place which would tend to weaken his influence or his numbers. It was, therefore, with great satisfaction that he received intimation from Te Heuheu of his intention to bring a large force to his aid; and, in effect, within two or three months after the commencement of hostilities, that chief, accompanied by other chiefs of note from Maungatautari and Taupo, amongst whom were Tariki and Taonui, reached Otaki with nearly 800 well-armed fighting men. No sooner had they arrived than they proceeded to attack the Ngatiawa at Horowhenua, a pa close to the Otaki River. But even with this great accession to his forces, the contest raged for several months with varying success, the slaughter in some instances being very great. In one of the battles Papaka, a favourite brother of Te Heuheu, was killed, and in another Te Tipi, a son of Rauparaha.

At length a great battle was fought at Pakakutu, in which the Ngatiruanui were defeated with serious loss, their chief Takerangi being killed and their pa taken. This battle put an end to the war, for soon afterwards the whole of the leading chiefs on both sides met, and upon the

advice and urgent entreaty of Te Heuheu and Whatanui, a peace was made, which was not again broken until the fighting at Kirititonga, which (as will be mentioned in the sequel) took place on the day before the arrival of the "Tory." Immediately after peace had been solemnly ratified the parties divided, the Ngatiraukawa proceeding to re-occupy their former settlements around Ohau and Horowhenua, and also the district between the Manawatu and Rangitikei Rivers, whilst the Ngatiawa retired below Waikanae, occupying the various points, including Port Nicholson, in which they were ultimately found by the agents of the New Zealand Company. Rauparaha, however, was so much grieved at what had taken place, and more particularly at the defection of that part of his own tribe which had joined the Ngatiawa during the recent struggle, that he determined to accompany Te Heuheu back to Maungatautari, and settle there for the remainder of his days. In pursuance of this resolve, he collected his more immediate followers and proceeded as far as Ohau, where, however, he was overtaken by messengers from Otaki and Kapiti, urging him to abandon his resolution and to remain with his people. In this request they were joined by Te Heuheu, and after much discussion and persuasion he consented to their request, returning to Kapiti, after taking leave of his great ally.

This was the last great struggle in which Rauparaha was engaged, but it seems that during the intervals of rest between his various more important undertakings, he was ever mindful of the treacherous attempt of the Muaupoko to murder him, and of the actual slaughter of his children, and had unceasingly persecuted the remnant of this tribe, until at last they, as well as the Ngatiapa and Rangitane, sought the protection of Te Whatanui. In the words of Te Kepa Rangihiwinui (better known as Major Kemp), son of Tunguru, one of the chiefs of the Muaupoko, who had been concerned in the murder, "Whatanui took them under his protection, and promised that nothing should reach them but the rain from heaven;" meaning that he would stand between them and the long-nursed and ever-burning wrath of Te Rauparaha. The latter unwillingly yielded to the wishes of his great kinsman, and from that time ceased directly to molest these unfortunate people, who were suffered again to occupy part of their original territory in the neighbourhood of Lake Horowhenua; not as a tribe, however, but simply in the character of tributaries, if not actual slaves, to Whatanui. In the words of Matene Te Whiwhi, "Rauparaha was anxious to exterminate Muaupoko, but Whatanui interfered. Some had been taken prisoners, but others were living dispersed in the mountains. When they came to Horowhenua, they came like wild dogs; if they had been seen they would have been caught and killed. There was one there, a woman of rank, whose possessions had covered all Otaki, and who had been a slave of mine. She was the wife of Te Kooku.

They had been taken but not killed." But it is clear, nevertheless, that although Rauparaha refrained from directly molesting them, he was not unwilling to join in any indirect attempt to exterminate them, for we find that on one occasion Wi Tako, in conjunction with some of the Ngatitoa chiefs, having been instigated by Te Rauparaha to do so, invited the whole Muaupoko people to a great feast to be held at Ohariu—upon some one of the numerous pretexts which the Maoris knew so well how to use for engaging in festivities, it having been arranged beforehand that these guests should all be murdered and eaten. The bait took, notwithstanding the advice of Whatanui, who, distrusting the reasons assigned for the festival, cautioned the Muaupoko not to attend, predicting some disaster to them. Notwithstanding this caution, upwards of 150 attended the festival, all of whom were slaughtered, and their bodies duly consigned to the ovens; but this was the last great act of slaughter of the kind which took place.

Shortly after the close of the civil war to which I have lately alluded, a section of the Ngatiawa tribe, known as the Ngatimutunga, which had taken up their quarters in Port Nicholson, chartered the English brig "Rodney" to carry them down to the Chatham Islands, which had been reported to them by a member of their *hapu*, who had visited the islands in a whaling ship, as being thickly peopled with an unwarlike and plump-looking race, who would fall an easy prey to such experienced warriors as his own people. This occurred about the year 1836, and within less than two years after the expedition reached the islands the aboriginal inhabitants were reduced from 1,500 to less than 200 people, the greater number having been devoured by their conquerors. In one of the cases in the Wellington Museum may be seen a bone spear, which formerly belonged to Mokungatata, one of the leading chiefs of the Ngatimutunga, who was known to have lived for a considerable time almost exclusively on the flesh of young children, as many as six of them being sometimes cooked in order to feast himself and his friends.

Harking back to the division of Te Rauparaha's forces, just before he left D'Urville Island for the purpose of attacking the Kaikoura Pa, that portion which remained under the leadership of Niho, Takerei, Te Koihua and Te Puoho, proceeded to attack the settlements of the Rangitane and Ngatiapa in Blind and Massacre Bays, which they entirely destroyed. Te Koihua settled near Pakawau, in Massacre Bay, where I frequently saw the old man, prior to his death, which happened but a few years ago. Strange to say, his love for green-stone was so great that even after he and his wife had both reached a very advanced age they travelled down the West Coast in 1858, then a very arduous task, and brought back a large rough slab of that substance, which they proceeded diligently to reduce to the form of a *mere*. Niho and Takerei, leaving Te Koihua in Massacre Bay at the time of their original incursion,

proceeded down the coast as far as the Hokitika River, killing and taking prisoners nearly all the existing inhabitants. Amongst the prisoners was Tuhuru, who was afterwards ransomed by the Ngaitahu for a celebrated *mere* called Kai Kanohi, now in the possession of the descendants of Matenga Te Aupori. Niho and Takerei settled at the mouth of the Grey, whilst detached parties occupied various points along the coast, both to the north and south of that river. I do not think it necessary to refer in any detail to the events which took place between the Horowhenua war and the arrival of the "Tory" with Colonel Wakefield in 1839. On the 16th November in that year the ship reached Kapiti, and Colonel Wakefield was informed that a sanguinary battle had just been fought near Waikanae on that morning between large forces of the Ngatiawa on the one side, and of Ngatiraukawa on the other. This fight is commonly known as the *kirititonga*, and was caused by the renewal, at the funeral obsequies of Rauparaha's sister Waitohi, of the land feuds between the two tribes. The forces engaged were large, and the killed on both sides numbered nearly eighty, whilst considerable numbers were wounded. Rauparaha himself took no part in the battle, reaching the scene of action after the repulse of the Ngatiraukawa, and narrowly escaping death by swimming off to his canoe, his retreat being covered by a vigorous rally on the part of his allies. This was the last contest which occurred between the natives along the coast in question, the arrival of the European settlers having entirely changed the aspect of affairs.

I need not here detail the arrangements made by Colonel Wakefield for the purchase of the country in the neighbourhood of Wellington, and along the coast to the northward, but it is worth while to extract from Mr. E. J. Wakefield's "Adventures in New Zealand" the account he gives of the colonel's first meeting with Rauparaha, of the appearance of the latter, and of the impression which he made upon his European visitors. "We had just made up a boat's crew," he says, "from the cabin party, to go over and see the field of battle, the surgeons taking their instruments with them, when a message arrived from Rauparaha. He was on Evans Island, the nearest to the ship of the three islets, and expressed a desire to see Colonel Wakefield. We therefore pulled round and went to see him. He had just returned from the scene of bloodshed, whither he asserted that he had gone to restore peace; and seeing the arrival of our ship, which was taken for a man-of-war by many even of the Europeans, he had betaken himself, with all his goods, to the residence of an English whaler, named Thomas Evans, on whom he relied for protection from some imaginary danger. We had heard, while in Cloudy Bay, that Rauparaha had expressed himself in somewhat violent terms towards us for purchasing Port Nicholson without his sanction; and he was described by the whalers as giving way to great alarm when told what the ship was, and as having

inquired anxiously what natives we had on board. As we leaped from our boat he advanced to meet us, and, with looks of evident fear and mistrust, eagerly sought our hands to exchange the missionary greeting. During the whole of the ensuing conversation he seemed uneasy and insecure in his own opinion, and the whalers present described this behaviour as totally at variance with his usual boastfulness and arrogance. He made us a pious speech about the battle, saying that he had had no part in it, and that he was determined to give no encouragement to fighting. He agreed to come on board the next day, and departed to one of the neighbouring islands. He is rather under the average height, and very dignified and stately in his manner, although on this occasion it was much affected by the wandering and watchful glances which he frequently threw around him, as though distrustful of every-one. Although at least sixty years old he might have passed for a much younger man, being hale and stout, and his hair but slightly grizzled. His features are aquiline and striking, but an overhanging upper lip, and a retreating forehead on which his eyebrows wrinkled back when he lifted his deep sunken eyelids and penetrating eyes, produced a fatal effect on the good *prestige* arising from his first appearance. The great chieftain, the man able to lead others, and habituated to wield authority, was clear at first sight; but the savage ferocity of the tiger, who would not scruple to use any means for the attainment of that power, the destructive ambition of a selfish despot, was plainly discernible on a nearer view. Innumerable accounts have been related to me of Rauparaha's unbounded treachery. No sacrifice of honour or feeling seems to have been too great for him, if conducive to his own aggrandizement or security. He has been known to throw one of his own men overboard in order to lighten his canoe when pursued by the enemy, and he had slaughtered one of his own slaves at the late feast at Mana to appear opulent in the eyes of his assembled guests. This was one of the poor, submissive, hard-working tributaries whom we had seen at the Pelorus. In his intercourse with the white whalers and traders and the shipping in the strait, he had universally distinguished himself by the same qualities. By dint of cringing and fawning upon those who showed power and inclination to resist his constant extortions, and the most determined insolence and bullying towards those whom he knew to be at his mercy, he succeeded in obtaining a large revenue from the white population, whether transient or permanent, which he invariably applied to the extension of his power among the natives. He was always accompanied in these marauding excursions, which he frequently extended over to Cloudy Bay and Queen Charlotte Sound, by Rangihaeata, who had become his inseparable companion since his rise in authority. Their respective stations were pithily described by one of the whalers, who told us that 'the Robuller' as he mispronounced his name,

'cast the bullets, and the Rangihaeata shot them.' Rauparaha was the mind, and his mate the body, on these black-mail gathering rounds. They had both acquired a violent taste for grog, and this, with fire-arms and powder, were the principal articles demanded."

Such is the account given by a writer, by no means favourable to Rauparaha, of the impressions he had formed of the chief upon their first interview, and although in some respects the picture he draws is not a favourable one, we may clearly see that its worst features are owing to the intercourse of Rauparaha with the class of European traders who then frequented the coast. Master as he was of all the treacherous arts practised by the Maori warrior, and ruthlessly as his designs were carried out, and fearful as the results may have been, it must be remembered that he was doing no more than his great countrymen, E Hongi, Waharoa, Te Wherowhero, and other leading chiefs who, during the same period, carried on wars in various parts of the islands. Those who knew Te Wherowhero Potatau will recall the peculiar dignity of his manner, and certainly no one would have supposed that the tall, graceful-looking man in the full dress of an English gentleman, who conversed with quiet ease with those whom he met in the drawing-rooms of Government House, at Auckland, was the same person as the savage who sat naked on the ground at Pukerangiora smashing the skulls of hundreds of defenceless prisoners, until he was almost smothered with blood and brains. Nor can I believe that Rauparaha was ever guilty of the treacherous conduct towards his own people with which he is charged by Mr. Wakefield. Their love and respect for him were very great, and the influence he acquired with such men as Te Heuheu and Whatanui indicates that he possessed the highest qualities as a chief. I had not intended to carry my story beyond the arrival of the "Tory," but I think it as well to give Rauparaha's own view of the disastrous affair at the Wairau in 1843, and of its results as related to me by his son.

"I will now," he says, "leave my account of the battles of Te Rauparaha at this end of the island, and speak of the folly of the Europeans and Maoris at Wairau, where Wakefield met his death. The fight, and death of Wakefield and the other European gentlemen in 1843, were caused by the deceit of Captain Piringatapu (*anglice* Blenkinsopp). He deceived Rauparaha in giving him a big gun for the purchase of Wairau. He wrote some documents in English, which said that he had bought that land. Rauparaha did not know what was in those documents, and signed his name in ignorance. Captain Piringatapu told Rauparaha that when he saw the captain of a man-of-war he was to show him the documents that he might know that they were chiefs. Rauparaha thought that it was all correct. When Rauparaha

returned from Cloudy Bay, near Wairau, he gave the documents to Hawea* to read; when he had read them he told Rauparaha that all his land at Wairau had passed away to Captain Piringatapu, and that he had received a big gun for it. Rauparaha was angry, and tore up the documents and threw them in the fire, also the documents held by the chiefs of Ngatitoa at Kapiti, and Ngatitoa of the other island. When Wakefield arrived, and the settlements of Nelson and Wellington were formed, he (Wakefield) went to Wairau for the purpose of surveying. Rauparaha did not consent as he had not been paid for it, since he had been deceived by Captain Piringatapu. Rauparaha's thought was that the land ought not to be taken by Wakefield, but that they should consider the matter before the land was handed over. Trouble and wrong was caused by the hurried attack of Wakefield and party upon Rauparaha. Rauparaha has told me a good deal about this matter. It was not his desire that the Europeans should be killed; his love to Wakefield and party was great. Rangihaeata, Rauparaha's nephew, was misled by his own foolish thought and want of attention to what Rauparaha had said. When Wakefield and party were dead, Rauparaha rose and said, 'Hearken Te Rangihaeata, I will now leave you as you have set aside my *tikanga*, let those of the Europeans that have been killed suffice; let the others live, do not kill them.' Rangihaeata replied, 'What about your daughter that has been killed.' Rauparaha replied, 'Why should not that daughter die?' Rauparaha also said, 'Now I will embrace christianity, and turn to God, who has preserved me from the hands of the Europeans.' This was the time when he embraced christianity. I was absent when the fight took place at Wairau, having gone to preach to Ngaitahu. I went as far as Rakaia. I was there one year, and was the first person that went there to preach. It was on this account that my father did not go there to fight. When Rangihaeata again occasioned trouble to the Europeans at the Hutt, Rauparaha was sad at the folly of Rangihaeata in withholding the land that had been purchased from him and Te Rangihaeata by the Europeans for £200. Rauparaha endeavoured to persuade Rangihaeata to cease causing trouble about that land, but he would not hearken.

"Rauparaha was afterwards taken prisoner by Governor Grey at Porirua without sufficient pretext. The following is the reason why he was taken:—A letter was written by some one, and to which the name of Te Rauparaha was signed; it was then sent to the chiefs of Patutokotoku at Wanganui. It is said that Mamaku and Rangihaeata wrote the letter and signed the name of Rauparaha to give it force. I was at school at this time with Bishop Selwyn at Auckland, together with my wife Ruth, and did not see the

* Hawea, or Hawes, was a European trader residing at Kapiti at the time of the transaction.

capture of my father. When I returned and arrived in Wellington, I went on board the 'Calliope,' the man-of-war in which my father was a prisoner, to see him. When I saw him we cried together, and when we finished he said to me, 'Son, go to your tribes and tell them to remain in peace. Do not pay for my arrest with evil, only with that which is good. You must love the Europeans. There was no just cause for my having been arrested by Governor Grey. I have not murdered any Europeans, but I was arrested through the lies of the people. If I had been taken prisoner in battle it would have been well, but I was unjustly taken.' I returned on shore with Matene and went to Porirua, and there saw Ngatitoa and Rawhiri Puaha. We told them the words of Rauparaha respecting good and our living at peace. We then went on to Otaki and repeated the same words. At this time we (two) caused the town of Hadfield to be built at Otaki. From this time Ngatiraukawa and Ngatitoa commenced to do right. At this time a party of Ngatiraukawa came to Ngatiwhakatere at Manawatu—this was the tribe that befriended Rangihaeata;—200 of the tribe came on to Otaki, and when they arrived we assembled. Rangihaeata invited these people that they might know the thoughts of Matene and myself respecting Rauparaha, who was held as a captive on board the vessel. He wished to destroy Wellington and kill the Europeans as a satisfaction. I told them the words of Rauparaha when we (two) went to see them (*i.e.*, the chiefs) and the young men. I told them they must put an end to this foolish desire, and not hearken to the *tikanga* of Rangihaeata, but that they must live in peace and cease that bad desire. They consented. The Ngatiraukawa consented to build that town, that they might obtain a name. When Rauparaha was liberated in the year 1846, he urged Ngatiraukawa to build a large church in Hadfield Town, at Otaki. Had he not returned, the church would not have been built. He had a great desire to worship the great God. He was continually worshipping until he died at Otaki on the 27th November, 1849."

Such is the history of the life and times of a very remarkable man, and of habits and customs which have already become so much things of the past that in the course of another generation there will be scarcely an aboriginal native left who will have the slightest knowledge of them. Indeed, the memory of the events I have related is already becoming indistinct, even to those of the principal actors in these events who are still living.

Art. II.—*On Moa Beds.* By W. B. D. Mantell, F.G.S.

[*Read before the Wellington Philosophical Society, 6th November,* 1872.]

It may be in the memory of some members now present that at a previous meeting during this session of our Society when the question of the antiquity of Moa remains was raised, one of our members referred to them as having been found in, or under, I forget which, a marine bed at Waingongoro, containing a certain per-centage of extinct species of shells, alleging as his authority a paper by my father contained in the Journal of the Geological Society of London, founded on information received from me. It will be remembered that I then expressed my surprise and regret that the paper or papers in question should be susceptible of so erroneous an interpretation, and promised to recapitulate for our Society all the facts relative to the occurence of the Moa which had come under my observation, whether those facts had or had not been previously recorded elsewhere. I am sorry that I did not qualify this promise to such extent as should only have pledged me to its fulfilment during our present session, should my other avocations permit—for, unfortunately, I have not since that evening been able to devote the necessary time and attention to the subject—and now that I have at last proceeded to some extent in the examination of my old letters, reports, and memoranda, I find that it will not be possible for me to compile a paper worthy of record without devoting to it far more time than remains to us of our present session. Such a paper, when completed, as in great part it will consist of a repetition of what has already been recorded, I do not regard as one which should necessarily be printed in our *Transactions*, but it may nevertheless be of use to future inquirers if deemed worthy of a place in our unprinted records.

But although unable at this time fully to redeem my promise I may yet be permitted, for the information of our Society, to note briefly the matter on which I propose to treat in my paper now in course of preparation. I take as its groundwork the notes of a paper which I read at the first meeting of the New Zealand Society in 1851, in which I spoke of the various conditions under which I had found remains of *Dinornis* and its contemporaries. In that paper I mentioned as the most ancient specimen which I had seen a fossil bone from a septarium of the blue clay of Onekakara, which, from its structure, had, by high authorities in England, been attributed to a bird. I have now grave doubts as to the nature of this bone, which I am disposed to think is more probably reptilian.

The tertiary deposit at Island Point, Waikouaiti, will next be noticed, and from my letters, written at the time of my examination of it, I shall endeavour to make its position and antiquity clear to the Society. From this

deposit it will be remembered that some of the most perfect and interesting of the early discovered Moa bones were obtained—the collection of Mr. Earle, the pair of feet found by Tommy Chaseland, some crania which I think were given to Sir George Grey, and many other specimens of great interest were obtained from this bed.

After noting several other places in which I formerly found these remains, under conditions which satisfied me that if contemporary with man these particular birds had not met their death through his agency, I shall pass to those probably more recent deposits which, from the circumstances under which they occur, were to my mind clearly accumulations of the refuse of human meals.

Of these, the first which met my observation was the very interesting sandflat of Te Rangatapu, near the mouth of the Waingongoro, a locality for Moa bones first discovered, I believe, by a member of our Society, the Rev. Richard Taylor, to whom I feel that some apology is due for the grievous poaching which I committed upon his manor.

This sandflat occupies a break in the coast-line cliffs through which it is evident that the river, at no geologically remote period, found its way to the sea; but the sand with which the gap is filled has no connection with the bed of finely laminated sand which is described as occurring in the neighbouring cliffs. It was in excavating in the old surface of this sandflat that I found the *umus* of the old inhabitants, and sundry articles of their use, such as fish-line weights, a *putu paraoa*, etc., and quantities of obsidian chips. Some of the larger bones too had, it seemed to me, been broken while fresh; the fractured ends offering a glazed surface instead of the rough, porous appearance of such as were broken in our attempts to extricate them. At this place, too, fragments of the egg-shells were first found: some much worn by what was mistaken by English geologists for the effect of water-carriage, but which was really attributable to the action of drift-sand. The result of my exploration of this flat—coupled with the tradition of the resident natives that it had been the first settled dwelling-place of their ancestors on their arrival from Hawaiki, and the Maori traditions concerning the existence of the Moa and the use of it by them as food, of its bones for implements, and of its feathers as ornaments—was a tolerably clear conviction to my mind that the birds, whose relics I found there, had been killed, cooked, and eaten by those ancestors. This conviction I strove to impress upon my home correspondents, but not with complete success, for they, supported by the opinion of a gentleman of higher scientific and official position in the colony, could not divest their minds of the idea that, occurring as these did in the surface of the material which filled an old river channel, they must have been water-borne from some inland locality.

In my account of this spot I shall be guided by the letters which I wrote at the time of my sending home the collections of which our president has suggested that I should furnish extracts.

The only other important discovery which I shall have to notice, is the old *kainga* at the stream now known as Awamoa, a name given by me instead of its original name of Te Awakokomuka, to prevent confusion with other streams of the latter name in the district. This *kainga*, which we found in 1852, afforded further unmistakable proof of the co-existence of man with the Moa. The bones and egg-shells of *Dinornis* and its kindred, mixed with remains of every available variety of bird, beast, and fish used as food by the aborigines, being all in and around the *umus* (or native ovens) in which they had been cooked. Although my collection from this place reached England in 1853 it remained unopened until after my arrival there in 1856, when I caused it to be conveyed to the crypts of the British Museum, and there unpacked it in the presence of the great authority on our gigantic birds, Professor Owen. With the exception of two small collections which were selected for me by Professor Owen, and which I gave, one to the Museum of Yale College, U.S., and the other to that of the Jardin des Plantes, the whole of this collection is now in the British Museum. The fragments of egg-shells from these *umus* varied in size from less than a quarter of an inch of greatest diameter to three or four inches. These, after careful washing, I had sorted, and having, with some patience, found the fragments which had originally been broken from each other and fitted them together, I succeeded in restoring at least a dozen eggs to an extent sufficient to show their size and outline. Six or seven of the best of these I gave to the British Museum after their purchase of the collection; one is in the Museum of the College of Surgeons; the rest, including one very beautiful egg with a polished ivory-like surface, are still in my ownership somewhere in England. Some idea of the labour entailed by this attempt to rehabilitate eggs may be gathered from the fact that several of those restored consisted of between 200 and 300 fragments. I may add that in the markings, size, and so forth, of the eggs (making allowance for the alteration of the former toward the ends of the eggs) I made out about twenty-four varieties, of which I have specimens.

At a meeting of the Zoölogical Society a discussion which followed the reading of Professor Owen's first paper on this collection, first showed me how unprepared were the scientific men at home to admit the co-existence of man with the Moa, but at its conclusion I conceive that doubts on that head were removed from the minds of most of those present.

With the exception of a slight notice in the New Zealand "Spectator" of 1853 no attempt at a detailed account of the Awamoa *kainga* has, so far as I remember, been yet published. I therefore hope that this portion at least of

my paper will be found interesting to those of our Society who have made Moa remains their study. But for this, as well as for the former part of my paper, I shall require the aid of diagrams to render my descriptions intelligible, and the materials for these I fortunately possess in my old letters.

I wish, in conclusion, to be distinctly understood on one point. I have not myself any fixed theory in connection with these Moas, their antiquity, or recentness. I feel that the information as yet accumulated is not sufficient to justify me in adopting any of the theories afloat, far less in venturing to add to their number. But while thus diffident myself, I do not feel called upon to withhold my respect from those who, with acuter intellect, or greater courage, step forward in the direction in which at present I dare not venture to advance; and by placing more clearly on record my own early observations of facts in connection with the subject of these theories, I hope to remove such stumbling blocks as they may have encountered from inaccuracies in previous notices of my collections, arising most probably from the imperfect manner in which I made myself understood to my correspondents at home.

ART. III.—*An Account of the First Discovery of Moa Remains.* By the Rev. RICHARD TAYLOR, F.G.S.

[*Read before the Wellington Philosophical Society, 6th November,* 1872.*]

IN the beginning of 1839 I took my first journey in New Zealand to Poverty Bay with the Rev. Wm. Williams (the present Bishop of Waiapu). When we reached Waiapu, a large pa near the East Cape, we took up our abode in a native house, and there I noticed the fragment of a large bone stuck in the ceiling. I took it down, supposing at first that it was human, but when I saw its cancellated structure I handed it over to my companion, who had been brought up to the medical profession, asking him if he did not think it was a bird's bone. He laughed at the idea, and said, what kind of bird could there be to have so large a bone? I pointed out its structure, and when the natives came requested him to ask them what it belonged to. They said it was a bone of the Tarepo, a very large bird which lived on the top of Hikurangi, the highest mountain on the East Coast, and that they made their largest fish-hooks from its bones. I then enquired whether the bird was still to be met with, and was told that there was one of an immense size which lived in a cave, and was guarded by a large lizard, and that the bird was always standing on one leg.

* In the discussion on the foregoing paper, Art. II. the Rev. Richard Taylor, F.G.S., made the following statement, which he afterwards reduced to writing.—ED.

The chief readily gave me the bone for a little tobacco, and I afterwards sent it to Professor Owen by Sir Everard Home; this took place in the beginning of 1839, and some months later another bone of the Tarepo was procured by a sailor in the same part, which was given to Mr. Rule, who forwarded it to Professor Owen some time before mine reached him, but I think I may justly claim to have been the first discoverer of the Moa.

On our reaching Poverty Bay (Turanga) I learnt that they were constantly finding these huge birds' bones. Mr. Williams soon after commenced a missionary station there, and a year or two later obtained a large number of these bones quite perfect. Some of them were forwarded to Dr. Buckland, and others to me, but one of those I received was a human bone.

Early in 1843 I removed from the Bay of Islands to Wanganui, and my first journey was along the coast of Waimate. As we were resting on the shore near the Waingongoro Stream I noticed the fragment of a bone which reminded me of the one I found at Waiapu. I took it up and asked my natives what it was? They replied, "A Moa's bone, what else? look around and you will see plenty of them." I jumped up, and, to my amazement, I found the sandy plain covered with a number of little mounds, entirely composed of Moa bones; it appeared to me to be a regular necropolis of the race.

I found the natives of the West Coast were totally ignorant of the name given on the other side of the island, the Tarepo. It was here I first heard of the word "Moa." I was struck with wonder at the sight, but lost no time in selecting some of the most perfect of the bones, and then considered what was to be done with them and where to bestow them. I had a box in which my supplies for the journey were carried, this I emptied and filled with the bones instead, to the amazement of my followers, who exclaimed, "What is he doing? What can he possibly want with those old Moa bones?" One suggested *hei rongoapea* (to make into medicine perhaps); to this the others consented, saying, *koia pea* (most likely).

This visit to the Waingongoro was the opening up of one of the most interesting fields of research for the naturalist. My enquiries after the Moa, and carrying off some of its bones, caused much talk among the natives. I was most anxious to obtain a skull of the bird. I was told there was a great one in a swamp some miles inland. I promised a large reward for it, and though they said I should have it they did not keep their word.

In reply to my questions about its size they told me it was quite as large as that of a horse, a sure proof that the bird had never been seen by any of those I spoke to. They, however, told me that these huge birds were formerly very abundant before the Europeans came, but they gradually diminished and finally disappeared. Their nests were made of the refuse of fern-root on which they fed, and they used to conceal themselves in the

koromiko (*Veronica*) thickets from which they were driven and killed by setting the thickets on fire; hence originated the saying, *Te koromiko te nakau i tunu ai te moa* (the *Veronica* was the tree which roasted the Moa). The koromiko when burnt emits a kind of rezin from its bark, which looks like grease, hence the origin of the saying, as all suppose the Moa to have been a very fat bird, which I should think was very questionable. When I next visited Waingongoro, expecting to carry off another load of Moa bones, I found, to my surprise, that they had disappeared. I afterwards heard that Mr. Mantell had passed that way after me, and had cleared the place of all worth taking. I seldom, however, travelled over the sandhills bordering the coast without finding some remains of the Moa, especially on those near the Wanganui Heads. On one occasion I found a large number of fine specimens, and being unable to take them with me on my journey I made a pile of them, carefully covering them up, and marking the spot, intending to remove them on my return, but when I came back I found every one had disappeared, some one else having found the prize and secured it.

One morning the chief John Williams brought me nearly a perfect skeleton of a very large Moa, which only wanted the skull to make it complete. The wind had blown away the sand from the old level, and upon it he found the bones, laid just as it had died, with the rings of the wind-pipe, and a heap of quartz pebbles which had once been in its gizzard. Thinking it highly probable a further search would enable me to find the skull, I rode to the spot and found my conjecture correct; the wind had removed the sand from a larger surface since my native friend had been there, and the first sight was a very gratifying one, there was the entire skull stretched out and partly imbedded in the clay soil, with the upper and lower bills quite complete. I found when I attempted to remove it that it was in a most friable state.

I succeeded, however, at last, and most carefully wrapped it up and placed it in the crown of my hat. I had scarcely remounted my horse before the animal began to buck-jump most violently; in an instant I found myself sprawling on the ground, with my treasure scattered about in innumerable fragments. Though in great pain I managed to collect some of the largest pieces, and amongst them the extremities of the upper and lower mandibles, which were afterwards sent to Professor Owen.

So abundant were Moa bones in former years that whenever a sandhill was shifted by the wind, and the old surface exposed, it was generally found to be strewed with the remains of the Moa, but the grand place to find them used to be in the shell-heaps—our Maori middens,—which form some of the most conspicuous objects on our western shores, where they stand out in bright relief amongst the sandhills. In the scarce months, which used to be called *mangere mumu*, the lazy grumbling season, the natives used to flock

down to the coast and subsist upon shell-fish or anything else they could find: sometimes a seal, more frequently a slave, and occasionally a Moa, whose bones are generally found entire, as they only are destitute of marrow. These are very interesting heaps, and well worth visiting as affording the means of reading some pages of Maori history in bygone days. The last visit which I paid to Waingongoro, was in 1866, in company with Sir George Grey. On our arrival there he asked me to show him the place where I discovered the great deposit of Moa bones in 1843. I took him at once to the place, and to my astonishment I found the hillocks almost as thickly covered with bones as when I first saw them; the wind had uncovered a lower stratum since my former visit. Several officers stationed at the neighbouring redoubt expressed their surprise when told the bones where those of the Moa. They had seen them times without number, but supposing them only beef bones, passed them without further notice. Several soldiers volunteered their services, and a great number of those old ovens were opened; all worked in good earnest, and no one more heartily than the Governor. It was quite amusing to see His Excellency grubbing up the old ashes, and carefully selecting what he thought worth carrying away.

A large cloth was spread on the ground, and the various articles found were piled upon it; these were of a very miscellaneous character, consisting not only of bones of the Moa, and fragments of its eggs, but of almost every other bird indigenous to these islands, including those of the kakapo and kiwi, with chert flakes, fragments of highly polished axes, and other articles. These ovens seem to have been made in a double line, and to have been used for many years, as each layer of ashes was separated by a thin stratum of sand from the one immediately below, and the number of them was very great. The natives informed me that when the Moa hunt was to take place, notice was given to the neighbouring places, inviting them all to the battue. The party then spread out to enclose as large a space as possible, and drive the birds from their haunts, then gradually contracting the line as they approached some lake, they at last rushed forward with loud yells and drove the frightened birds into the water, where they could be easily approached in canoes, and despatched without their being able to make any resistance. These Moa hunts were, doubtless, very destructive, as from the number of men employed, and the long lines of ovens, the slaughter must have been very great; and, in addition to this, from the large quantity of egg-shells, a clear proof is given that they were eagerly sought for and feasted upon. Thus, the poor birds had little chance of continuing their race. Another cause of their disappearance may be also mentioned, the extinction of the tuatara, the largest lizard existing on these islands, on which they are said to have fed, with other varieties of the same family, which since the introduction of the

cat have also passed away. Thus the Moa may be said, without doubt, to be extinct in this island, whether it is so in the other is a question still to be decided, and if it should be urged that so large a bird could not well escape being seen, it may be said in reply that being in all probability a night bird like the kiwi, and one of solitary habits, selecting the most lonely places, and such haunts still abounding in the alpine regions of the south, it is by no means improbable that it still survives. I may also state that the plain of Waingongoro is called Rangatapu, which may either apply to the hunters (the sacred band) or the ovens (the sacred row), and that the name Moa, like that of the roa, was most probably derived from the bird's cry. Amongst the islands to the north the name of Moa is applied to the domestic fowl. The Moa has passed away, and its hunters as well, and the proverb is being fulfilled,—

Kua ngaro a moa te iwi nei;
"The Maori, like the Moa, has passed away."

ART. IV.—*On New Zealand Lake Pas.* By the Rev. RICHARD TAYLOR, F.G.S.

[*Read before the Wellington Philosophical Society, 9th October,* 1872.]

IT is now nearly thirty years since I first visited Horowhenua Lake, which, though not of great extent, is still one of much beauty. I was then struck with its singular appearance from a number of *watas*, or native store-houses, being erected on posts in the middle of the lake, and seeing the natives ascend to them from their canoes by means of a notched pole.

When afterwards, in 1854, the remains of villages were discovered in the Swiss lakes, and similar ones, called crannogues, in Ireland, it then struck me that the same practice had formerly prevailed in New Zealand, and especially in the Horowhenua Lake, and that the *watas* I had seen there were but remnants of the custom. On putting the question to Tamihana Te Rauparaha he said that he recollected two pas being in it, which belonged to the Muaupoko tribe, the ancient owners of the district, and that one was called Te Namuiti, but he could not recollect the name of the other.

Afterwards I was so fortunate as to obtain from an old chief of the Muaupoko tribe a sketch of the lake, in which he placed six pas, giving me their names and positions. Their sites are still to be seen, as so many islets, covered with a luxuriant vegetation. The old chief also described the way they formed them—first by driving strong stakes into the lake to enclose the required space, then by large stones being placed inside them, and all kinds of rubbish being thrown in to fill up the centre, upon which an alternate stratum

of clay and gravel was laid until it was raised to the required height, on which the houses were then erected, and the pa surrounded with the usual fence. The only approach being by canoe they were secure from any sudden attack. Rauparaha and his tribe took them. Such a dread of that redoubted warrior seized their inhabitants that when they saw his fleet approaching they lost no time in making their escape to the surrounding forest. Rauparaha landed and burnt them all. This was about the year 1825.

These lake villages differ from the Swiss ones, which were built upon platforms resting on posts driven into the lake, and connected with the shore by a pier, having a rude drawbridge in the centre, which could be drawn up at night, or on the approach of an enemy, but the crannogues of the Irish lakes, on the contrary, were artificial islands closely resembling in their construction those of the Horowhenua Lake. They were formed by sinking beams and logs, and then erecting walls of large stones upon them, filling up the centre with stones and clay. This was by no means an uncommon mode of defence amongst the Maoris. In the Papactonga, a neighbouring lake to that of Horowhenua, there were two pas of a similar kind. On Motutaiko, a small island in the centre of Taupo Lake, there was a formidable pa, to which there was only one landing place, and that was strongly defended. Another existed on an island in Rotokakahi Lake, and perhaps the most celebrated of all was that of Mokoia, in the centre of Rotorua Lake, where their most venerated idols were kept, and the only resemblance of a temple found; there also their greatest warriors were buried.

Probably the idea of making artificial islands for defence may have originated from these natural islands being used for that purpose.

Art. V.—*A Description of the Earnsclough Moa Cave.* By the Hon. Captain Fraser, F.R.G.S.

[*Read before the Wellington Philosophical Society, 4th September,* 1872.]

This cave was accidentally discovered by a young lad named Weir, who was taking a short cut to his father's claim.

The boy mentioned the discovery to his father, who visited the cave, and carried away with him that which he considered the most interesting object. This he sold to Dr. Thomson, of Clyde. I allude to the skin-covered neck of the Moa, which is at present on exhibition in the Colonial Museum. I was in Dunedin when I heard of the discovery, and it was my intention to have made an exhaustive examination of the cave, which is on a run in which I have an interest, but, unfortunately, before I arrived at Earnsclough, Mr. Arthur, surveyor, and Dr. Thomson, of Clyde, made a *razzia* on the cave, and

carried away a very large collection of the best preserved Moa bones I have ever seen, and I have been a collector for many years. Several of these bones have bunches of sinews attached to them, and are in other respects so perfect, showing neither abrasion nor the slightest indication of having travelled even the shortest distance, that I could come to no other conclusion than that the gigantic birds to which these various sized bones belonged must have perished within the cave.

Very shortly after my arrival at Earnsclough I proceeded to visit the cave, accompanied by my son. We crossed the lower end of the Dunstan basin, and entered by a narrow gorge the once beautiful valley of the Conroy, now a hideous chaotic mass of alluvial workings. This valley contained rich auriferous deposits, and in course of the workings vast quantities of Moa bones were discovered at varying depths, from one to fifteen feet.

We passed Pipeclay Gully, in which was found the lower jaw of a Saurian in a perfect state of preservation. It is now in the possession of Dr. Thomson, of Clyde. The jaw is somewhat larger than, but in other respects similar to that which was found in the Glenmark swamp, and at present in the Canterbury Museum. About four miles from the gorge we turned suddenly to the right, and crossing the Conroy we commenced a gradual but oblique ascent of a spur of the Umbrellas. After attaining a height of about 800 feet above the Conroy we found our further course in this direction stopped by a wide and deep gully, the edge of which bristled with huge castellated-looking dark rocks, large slabs from which had slipped down and lay on the side of the gully. At the foot of one of the largest of these rocks, and in the centre of a platform about twenty yards square, one side of which formed the edge of the gully, we found the entrances to the cave, which are about twenty feet apart. We lighted our lamp, and descended by the perpendicular entrance, and, after some scrambling, we found ourselves on a landing place which was lighted from the other entrance, which was of an easy gradient, but so low that when we made our exit from it we were compelled to go on all fours. The roof between the entrances is composed of a rock, the upper surface of which is covered with a well-grassed turf. The stone shows no sign of recent displacement, and may have been in its present position for a thousand years. The floor of the landing place is composed of rubbish of various kinds, including partially charred Moa bones. It was not difficult to account for the charred bones; the shed from the scrub at the entrances had accumulated in the dry cave until such time as it fell a prey to our great grass fires. There was not the slightest indication of man having inhabited the cave. After leaving the landing place we entered what I may call the true cave. Here we found the gradient so steep that the fine dust which covered the floor of the cave to a considerable depth slipped down from under our feet like sand. And I may here remark

that each visit to the cave assists in choking up the lower part of the cave with this impalpable dust, which will yet have to be carefully removed and examined. Groping in this dust with my hands I found several bones and rolls of what I imagined to be the inner bark of a tree. I put a small piece of this in my pocket for examination, and on coming to daylight I was surprised to find that what I took for bark was reddish-brown Moa skin.

Observing a lateral passage, through which the wind was blowing freely, my son followed it in the hopes of finding an exit in the face of the gully. This horizontal passage led into the solid rock, and at right angles to the cave. My son was absent so long that I ceased to hear his voice. On his return he reported to me that he saw no bones, the floor of the passage being hard rock.

From the junction of this passage the cave descended at a very steep gradient, and at one place a wedge-shaped narrow rock compelled us to creep underneath, which was not difficult, as the floor was well covered with the fine dust which followed us as we advanced, filling up all interstices, and no doubt hiding many interesting objects from our view.

Soon afterwards we found ourselves at the bottom of the cave, and here I much regretted that I was not provided with a few inches of magnesium wire, as not only sound but light was absorbed in this den, so that I could hardly see a yard from the lamp.

My son, who was fossicking about with a piece of totara which he picked up in the cave, suddenly exclaimed, "I have found a nest," and, true enough, from under a ledge he drew out grass and the remains of the eggs and birds, which are at present in the Museum on exhibition.

I remarked several pieces of totara in the cave, which would lead one to suppose that the totara tree grew on the platform, before the original mouth of the cave was closed by the rock which forms the roof of the present landing-place.

The neck of the Moa was found in that part of the cave above the junction with the lateral passage, and as there was always a current of dry air there, it may account for the neck being so well preserved.

On leaving the cave we proceeded to search the gully face of the rock for the ventilator. We were not long in finding a weather-worn funnel-shaped cave; the back orifice of this funnel was six inches in diameter; there was a strong in-draught through this aperture, which carried grass and light objects into the cave. We found a sound stick of totara in this cave, which is at least forty feet below the level of the platform. Above the ventilator, and on an inaccessible ledge of the rock, we saw a large piece of totara which had been left there since the parent tree had crashed in its fall against the face of the rock. With some difficulty we dislodged it by throwing large stones on it

from above. It was so hard and tough that we could not break off the smallest piece of it.

As I could not divest my mind of the impression that the original entrance to the cave was in the face of the gully, I narrowly examined the ground opposite to what I judged to be the bottom of the cave, and found that a vast detritus had fallen from above which might well have crushed in the mouth of the cave and buried it from view. I have shown that a long slope leads up to the cave, which is bounded on the other side by the deep gully. Storm-water coming from the mountain would naturally run down the slope or into the gully. It certainly could not come on the platform bearing Moa bones with it.

The platform could never have been the camping ground of anything living, as the wind blows so fiercely across it as to tear up large sheets of mica schist from the exposed edge of the gully.

On returning from the cave we examined what we considered, on our ascent, might be the entrance to another cave. The aperture was narrow, and choked up with growing scrub. Having broken this down, and tied our bridles together, my son dropped into the darkness and struck the ground at about twelve feet. Having no light he could not explore the cave, which appeared to be of considerable size, and dangerously precipitous. He sent up by means of the bridle a large pelvis of a Moa, which I left on the rock to mark the cave.

ART. VI.—*On the Effect of Wind-driven Sand as a Cutting Agent.* By EDWIN STOWE.

[Read before the Wellington Philosophical Society, 25th September, 1872.]

IT may be interesting to those who are acquainted with the sand-worn stones of Lyall Bay, either from personal observation, or from Plate XVII., in the second volume of the *Transactions*, and the description there given by Mr. W. T. L. Travers, to know that on another part of our coast effects similar to those thus far observed are being produced by somewhat similar action.

The southern bank of the Waikato river for the last few miles of its course is formed by a range of sandstone, for the most part still covered by the natural vegetation of the district. But northwards from the point where this range, meeting the sea, forms a line of abrupt cliff making away to the south, there extends for a distance of about a mile, up to the actual river mouth, a long bank of considerable elevation, composed of fine sea-sand. This is entirely devoid of the vegetation usually found upon sand-dunes, and lies fully exposed to the action of the S.W. gales, which blow with such force on this part of the coast. The landward, or eastern slope of this sandy elevation, is for the most part exceedingly abrupt—as abrupt as it is possible for loose sand to be—so much so, indeed, that at a distance it appears to be a

precipitous cliff-like wall. Its base rests on an irregular undulating tract, for the most part also covered with light moveable sand, that occupies the angle between the long sand-dune and the ranges before mentioned. On this undulating tract may be found banks or beds, ordinarily about the width of a common roadway, composed of blocks of pumice that have been brought down by the waters of the river from the interior of the country. Deposited in their present position, in the shape of rounded boulders, they have been subjected to the cutting action of drift-sand till the upper portion of each mass has been cut away, and the whole bed offers a uniformly level surface, slightly depressed centrally. In this condition the beds present the appearance of paved roadways, or rather of inlaid pavements. That the blocks of pumice, of which they are composed, must have been originally deposited as rounded boulders, is sufficiently clear from the fact that the pumice, freshly thrown up by the ocean on the open beach, as well as that thrown up either by the tide within the river or by the river itself beyond the limits of the tide, is invariably devoid of angular form. The specimens removed from one of these beds will best show how sharp an edge has been produced where the original curved surface sunk in the sand is met by the intersecting line of the newly-formed plane.

Wherever the pumice has been exposed along the external margin of these beds other forms may be observed, many of the blocks showing signs of the tendency that sand has to cut a sharp ridge on stones so placed. In isolated situations it is by no means difficult to find examples very similar to those already referred to as having been found at Lyall Bay. On these a sharp ridge is to be noticed—doubtless the effect of the alternate action of two currents—one, probably the stronger, being the one setting in from the sea, the other blowing down the river in an opposite direction. This effect was very noticeable in the case of a large isolated block, about the size of an ordinary milestone, that had become firmly imbedded in the sand, and which had been cut on two faces—the apex viewed laterally presenting the appearance of a sharp point. But the specimens brought away, though on quite a small scale, are sufficient to show the general form that is produced in this locality under the influence of the action of drift-sand, subject to alternate currents of wind.

Art. VII.—*On Local Variations of Atmospheric Pressure dependent on the Strength of Winds.* By J. S. Webb.

[*Read before the Otago Institute, 22nd July, 1872.*]

On the 2nd of December last the Field Naturalists' Club should have met for an excursion to the saddle between the Water of Leith valley and Blueskin.

There being no attendance at the appointed hour, nor for long after it, the indefatigable honorary secretary of the club, not caring for a lonely walk, abandoned the excursion. Mr. Blair and the writer arriving late, and each supposing the usual party to be ahead, undertook the ascent, and they presently joined one another. Mr. Blair, who has a keen eye for possible railway tracks wherever he goes, was, when I overtook him, engaged in noting the height of the barometer, with the view of estimating the elevation of the point he had reached. Similar observations were continued throughout our walk, which extended to a mile or so beyond the summit, and were repeated during the descent at most of the points adopted during the upward journey.

Coming down we noticed an increasing discrepancy between the two sets of observations, the new ones showing decreased atmospheric pressure. We were, of course, prepared to find that the barometer at the sea level had fallen during the afternoon, and expected that the reduction of our observations would give us much trouble in consequence, and probably be far from reliable as measurements of height. As we began to emerge from the narrower part of the gorge through which the Water of Leith flows, we found the difference between the first and second observations began to decrease, and finally, when we reached the sawmills, the two coincided, which was again the case at the intersection of Castle-street and Albany-street, where Mr. Blair made his first observation of the barometer. This curious phenomenon caused us some perplexity. After consideration I am inclined to attribute it to the effect of a fairly strong wind which was blowing from the S.W. when we started, but which subsided during the afternoon. In a valley so completely shut in as that of the Leith during its upper course, and descending so rapidly from the saddle, which lies at about 1,100 feet above the level of the sea, it is certain that a strong breeze blowing almost directly into it at the lower end must cause increased pressure in the lower strata of air.

The following is a list of our observations :—

TABLE OF OBSERVATIONS OF ATMOSPHERIC PRESSURE, 2ND DECEMBER, 1871.

Points of Observation.	During Ascent.	During Descent.	Difference.
Castle Street	29·69	29·69	...
Leith Bridge	29·60	29·60	...
Ross' Creek	29·58	29·53	·05
N.W. corner, Section 7	29·42	29·36	·06
Nichol's Stream...	29·30	29·23	·07
Cedar Creek	29·20	29·12	·08
Ford of Leith	29·19	29·11	·08
Cuthbertson's	28·83	28·78	·05
Section peg $\frac{42}{59}$	28·78	28·74	·04
Saddle	28·43	...	...

Since the aneroid barometer came into use barometrical measurements of altitude have become very common, but I am not aware of any scientific work in which the subject is treated at all fully.

The officers of the United States Survey, engaged on the survey of the western slopes of the North American continent, are reported to have made careful and elaborate investigations, and to have constructed hypsometrical tables suitable for all altitudes above the sea-level, but I have not been able to obtain any work containing an account of the results they have arrived at. Whether facts similar to those I have detailed above have been previously noted I have not been able to discover, and my chief object in presenting these notes to the Society is, if possible, to elicit information on the subject.

Art. VIII.—*On the Reclamation of Land devastated by the Encroachment of Sand.* By C. D. Whitcombe.

[*Read before the Wellington Philosophical Society, 25th September,* 1872.]

The subject of reclaiming land devasted by the encroachment of sand is one of the greatest importance to the settlement of Taranaki; in fact, to the west coast of this island in general, if not to the eastern portion of it.

It is now admitted that the bars at the mouths of rivers are principally formed of sand driven along the coast or washed in by the sea; that where there is a bar it will be found that the soil is loose, both at the bottom and on the sides where the river discharges; and that with rocky bottom and sides there is generally no bar.

At New Plymouth we have a drift following the prevailing current and set of the tide, from north to south and from south to north we have the shore drift blown along coastwise by the prevailing winds; besides these, there is the large amount of detritus carried down every river by every rain, and which is increased to a maximum by the process of first clearing a loose virgin soil. These three operations combined must tend to create and maintain bars, generally of a horse-shoe shape, at the mouths of our rivers (unless the tidal pressure is transverse to the flow of the river, and much stronger than this latter), infinitely to the prejudice of navigation.

Again, the effect of the drifting of sand in large quantities is gradually to choke up the smaller streams, backing their waters, and causing the formation of swamps and marshes along the line of their course; and finally, if left unchecked, the sand drifts further and further inland, creating ever-increasing areas of desert land. Anyone who has observed the rapid encroachment of the sand in this province, will at once own that within very few years damage has been done to an enormous extent in all the three modes pointed out

above, and will not think the subject one undeserving the attention of the Legislature.

In France the subject has long since been legislated on. By the 41st section of the law of 16th September, 1807, the government was empowered to make grants of sand-lands to individuals, under certain prescribed regulations for planting them; and also to undertake itself the work of reclaiming the soil, whether by plantation or otherwise, as might be considered necessary. Under certain circumstances, when the encroachment of sand on the property of any individual, without sufficient efforts on his part to arrest it, threatened to do any public injury, the law of 7th July, 1833, might be brought into operation, under which the said lands were valued by arbitration, and the government, paying the amount of valuation to the proprietor, took over the land, and dealt with it under the law of 1807. Later still, the government has adopted another auxiliary means of dealing with the matter, and now, through the intervention of the *Conseils Généraux* of the Provinces, makes grants of seeds of pines, etc., to the districts troubled with sand, and also makes grants of money to cultivators who have succeeded in arresting the sand over a certain area by means of the *oyat*.

Now as to the means generally adopted. The first place to commence plantation on is the generally level space between high-water mark and the foot of the downs, or sandhills, over which the sand, propelled by the wind, travels without stoppage. It is well not to operate on too extended a surface at once. The plants which are more especially suited to this purpose are those which not only can grow in the driest sand and live in an atmosphere impregnated with saline exhalations, and even with salt sea spray in high winds, but, above all, those whose roots have the property of spreading closely and compactly for considerable distances, and whose stems possess a toughness which preserves them for a lengthened period.

The following is the system which has been generally adopted in sowing: Take one-third (rather in number than in bulk) of seeds of the trees and shrubs you intend to sow, and to this add two-thirds of seeds of plants of as rapid a growth as possible, whose stems will shelter for the first few years the ligneous plants, and prevent their roots from becoming bare and exposed. The sowing should be thick and broadcast, and the seeds covered by a light harrowing. Then, to lessen the mobility of the soil, branches of trees, fresh cut, with their leaves on, or, in default of these, branches of broom or furze, are spread and fixed on the surface by means of pegs; these afford a shelter from the drifting effect of the wind and from the rays of the sun. If branches, etc., cannot be procured in a sufficient quantity, the following plan is adopted: Fascines of a tolerable thickness are united in lines and disposed chess-board fashion (like Maori *taro* beds), and the sowing is made. In a few years a

first line of plantation is made, and reclamation of sand-land proceeds rapidly behind it.

Cuttings are also made use of, especially of the *Tamarix gallica*, or tamarisk. The topinambour, or Jerusalem artichoke, is also very valuable, as also are the larger sun-flowers and the whole tribe of mesembryanthemums. The following plants are also worthy of notice, and may be employed with great advantage, viz.—*Eryngium maritimum*, or sea holly; *Convolvulus soldanella*, or sea bineweed; *Glaucium luteum*, or yellow-horned poppy; *Euphorbia peplis*, or purple spurge; furze, broom, and the sallow, may be also sown, though the former is far from advantageous in a plantation of trees, choking the young plants. But, for rapidly arresting the march of sand, and fixing it, the following plants have been found most efficacious, viz.—*Arundo arenaria*, or sand-reed, known in France as the "Oyat des Côtes du Nord"; *Elymus arenarius*, or sea grass, and rye grass. The *oyat* is infinitely superior to all the others. The best tree to sow is the *Pinus maritima*.

The season for planting or sowing must be that in which there is the greatest continued supply of moisture to allow time for growth of seeds, or striking of cuttings. New Zealand I consider peculiarly favourable as to climate for the reclamation of such lands.

I have by me some peculiarly valuable reports of M. Alexandre Adam, who undertook the reclamation of downs in the Pas de Calais on a very large scale for the *Conseil Général* of that department. They were sent me as a special favour by M. M. Vilmorin Andrieux, of Paris, who are friends and Paris agents of this gentleman. They cover from 1864 to 1869, both years inclusive, and are, I am informed by M. Vilmorin, unprocurable now, and invaluable from their information. From them I have obtained many of the details I have given you. He proceeds by sowing *oyats* and *Pinus maritima*, and conducts the matter with a view, not only to expenses of reclamation being covered, but to the reaping of a large profit. As the pines grow up they are thinned out, and forest trees, especially oak, birch, elm, and ash, planted. Within the first line of plantation seeds of these trees are sown together with the *oyats* and pines.

I may add that the poplar is found very valuable, both for sowing, planting, and multiplying by cuttings. In some places, where the sand was very deep and dry, M. Adam found that instead of sowing it was preferable to take large cuttings of poplar, set them one yard deep in the sand and two yards apart every way; these almost invariably struck, even on the highest sandhills, and in the most exposed situations where nothing else would grow. I trust this information will be found of service, and that some grounds may have been shown for urging on the Legislature the importance of following the example of the French legislature, who, by their wise action,

have caused the reclamation of hundreds of thousands of acres of land from a state of desolation to fruitfulness. Everyone can see with their own eyes the rapidity with which, on the other hand, land is drifting in this province and elsewhere in the colony from fruitfulness to desolation.

ART. IX.—*Directions for Raising and Spreading* Ammophila arundinacea *and* Elymus arenarius. By J. C. CRAWFORD, F.G.S.

[*Read before the Wellington Philosophical Society, 23rd October,* 1872.]

IF the seeds of these grapes are simply scattered on the sandhills there will be great waste of seed; much will be blown away and lost, particularly if sown where the sand is actually in motion.

1. If there is any good land at the place a nursery ought to be fenced in and a quantity of plants raised there as a stand by. When well established a number of these plants should be broken up every winter and planted out, but care should be taken to replant in the nursery, and to keep it permanent.

2. In sowing beds in the open, particularly late in the season, moist and sheltered places should be selected, and the seeds trodden in or slightly covered.

3. When the plants are fairly grown and form large bunches a number of them may then be broken up into several hundred plants each, and planted out. They must be planted deep so as to have a good hold of the ground, otherwise many will blow out. It is also advisable when planting to cut off the tops of the leaves, as the plants do not then suffer so much from the wind before getting rooted and established. I use, for planting, a small spade, and make a slit, well opened, the full depth of the blade.

4. It is advisable to commence planting in hollows surrounding the sand-hills and gradually to work round them.

5. It will take a year or two before the plants make much show, afterwards planting out must go on all through the winter season.

6. The planting out of these grapes requires thought, judgment, and constant attention, otherwise a very small result will be attained.

ART. X.—*On the Taieri Floods.* By G. M. BARR.

[*Read before the Otago Institute, 12th March,* 1872.]

MANY schemes have been suggested for the prevention of the floods which have been so disastrous to property on the Taieri plain, but those which were generally recognized as the most practicable have usually been estimated at so

great a cost as to exclude the probability of their being carried out either by the residents on the flooded area or the Government; while there is one which has been mooted upon several occasions, but dismissed almost as soon as mentioned, which appears to me worthy of more consideration. Having had for some time the feeling, scarcely raised to the position of an opinion, that the proposal to form a store reservoir at the Taieri Lake had not received sufficient attention, I took the opportunity, while in that neighbourhood last December, of spending some hours in making a careful examination of the physical features at the outfall, and I now propose to investigate how far the damming back of the waters of that part would tend towards the prevention of those disastrous floods to which the Taieri plain has been subjected in late years. Unfortunately, I have not at command sufficient information either as to the rainfall or the configuration of the ground, to give exact quantities in dealing with the whole of this subject; but for purposes of preliminary enquiry we may find enough either from direct observation or from general laws which may bear upon the subject. In the following calculations I have been much indebted to the elaborate survey executed in connection with Mr. J. T. Thomson's report upon the subject in 1870, which has been kindly placed at my disposal. Other parts are filled in from the general map of the Province, and by personal observation.

Before considering the case I shall glance briefly at the nature and proportions of the evil, for without a knowledge of these we cannot judge of the feasibility of any proposed remedy.

Referring then to the map of Otago, we find that the lower Taieri plain lies at the mouths of the Taieri and Waipori rivers and the Silverstream, all discharging large quantities of water during floods, especially the former river, which has an outpour per minute through the gorge at Outram, even at its lowest, nearly equal to that of the Clyde in Scotland between Glasgow and Port Glasgow; but having a fall very much greater, the cross section is correspondingly less. By computing the drainage areas of these local rivers, we find that into the basin occupied by the Waipori and Waihola lakes, and the Taieri plain, there is discharged that portion of the rainfall over 2065 square miles of country, which has escaped evaporation or absorption by plants or porous strata, the relative areas being—

	Square Miles.
Taieri river	1,730
Waipori	265
Silverstream	70
	2,065

The Silverstream being comparatively small, and the waters of the Waipori being discharged into the lake of that name, with an effect upon the floods

only in connection with the Taieri, I shall simply refer to them at that stage when we come to view the storage room on the lower parts of the plain, and shall devote this portion principally to the nature of the larger river and its floods.

A comparison of the Taieri with the chief rivers of Europe or North America will show that in proportion to the country drained it is much in excess of the most of these as a flood producer. Thus, while it pours down its water at the rate of 1·066 cubic yards in the second for each square mile drained above Outram, the Mississippi in flood flows only at the rate of 0·044; the Ohio, at its mouth, 0·122; and the Yazoo 0·372 cubic yards per square mile drained. In Great Britain, the Tyne is the only one which approximates to the Taieri in this respect, its rate of flood discharge being 1·12; but small streams which have been gauged in meadow land have yielded as much as 1·2. The Yellow River, in Ireland, is as high as 4·12. On the continent of Europe the Loire appears to be pre-eminent for its floods—yielding at Pont de Fleurs as much as 4·18 cubic yards per second for each mile drained. Many of the Indian rivers far exceed any of the above—the Irvitz, especially, delivering at the rate of 16·5 cubic yards per second for each square mile of its gathering ground.

Now these figures of course represent very rough comparisons between the several streams named, no two of which are alike in physical conditions, either as to amount of rainfall or configuration of drainage area; but in a general way they enable a classification to be made which may yet be further improved as information is gathered. Apart from the relative quantities of rainfall, there are many other circumstances which tend either to aid or impede floods. Thus a stream draining a large tract of country is much less liable to heavy floods than one draining a small one; and also the general nature of the country as to inclination has a most noticeable effect upon the rate at which the water finds its way to the river, and consequently a like effect upon the amount of its volume. Another most important consideration is the nature of the strata, or the amount of vegetation in the district drained; for when the rocks are of a close compact nature, with comparatively few joints or crevices, and the ground bears but little vegetation, the water will run quickly off; but where the ground is porous, and the vegetation rank, a much longer time will elapse before the underground basins are filled, and the ground so saturated as to shed the water off as the rain falls. Surface lakes have a comparatively greater effect in moderating floods than either of the above causes, by receiving the water as it comes from the creeks, and allowing it to spread in thin films instead of rushing down a river channel in deep volumes.

Having got these general results, we may now endeavour to examine

particularly the conditions of the Taieri drainage ground, with a view to ascertain, if possible, in what respects it facilitates the rapid discharge of the rain or melting snow, and it will then be seen that the chief features likely to promote this are the generally mountainous character of the catchment area, with the exception of the Upper Taieri plain, the steep inclination of the ridges, the nature of the rocks, and the general steep declivity of the bed between the upper and lower plains. On the other hand the upper of these plains forms a natural basin about 280 square miles in extent, but of this only about one and a half square miles are an open lake, the remainder being deposits of shingle of various depths lying upon impervious clay, and capable of being a store reservoir only to the extent of the interstices between the stones. That portion, in fact, resembles a huge sponge, acting with the open lake in retaining the water, and preventing to a certain extent its sudden rush down the channel towards the lower parts. The lake lies at the flank of the Lammerlaw or Rock and Pillar range; and finds along with the Kyeburn an outlet through a narrow gorge, at one place not wider than 110 feet, but unfortunately its low level limits the capacity of the whole reservoir as a flood moderator. The point now is, to consider the practicability of raising that outlet to such an extent as to store the greatest flood waters that are likely to occur, and release them only at such a rate as shall not be prejudicial to the low grounds lying below Outram.

The flood of 4th February, 1868, being the greatest on record, I shall take as the standard one, seeing that it is necessary in any remedial works that may be proposed to provide against the occurrence of an evil at least equal to that already experienced.

The circumstances of rainfall attending the floods of January and February of that year, at least so far as we can judge the Taieri basin by observations taken at Dunedin, were almost such as to lead us to expect that no such floods are likely to occur for very many years. Upon examination of the meteorological tables prepared by Dr. Burns and the Meteorological Department, it will be found that the unprecedented nature of the January and February floods was more owing to the extreme degree of saturation in which the ground must have been by months of previous rain, than to even the heavy rains of any one particular day. Doubtless these were very heavy, but not so much so as several days both before and since, which did not produce the same rise in the water. For the months of October, November, December, January and February, the rainfall ranged from 5·0 to 8·078 in., thus showing a continuance of wet weather unequalled, I believe, in the history of the settlement. In the case of the flood of January, 1870, which did not rise so high as the one we are specially considering, the rainfall recorded in one day exceeded that shown upon 4th February, 1868, but that

followed some months of comparatively dry weather, though it commenced one showing a total of 7·399 in.

Floods may also suddenly arise after a drought, from the fact of some kinds of soil being so thoroughly baked as to have a surface almost as impervious to rain as rock itself, and thus it delivers the water almost as it falls; but such floods will be of short duration, and only until the surface has had time to soften a little and allow the usual amount of soakage.

I have referred to the rainfall at Dunedin, because unfortunately we have no records of its amount for the Taieri basin, and if we were wanting to go minutely into the matter, as we shall see immediately, the rain gauge in this city would be apt to mislead rather than enable us to arrive at correct results. Those who have paid any attention to meteorology must be aware of the great diversity of rainfall in different districts, even within a few miles of each other, and consequently of the necessity for separate observations in various localities, if any practical result of value is to be evolved. We are safe enough, however, in taking the evidence of the Dunedin observations to prove generally a season of unexampled moisture within the Taieri basin; but it will be seen by a study of the figures representing the flow of the Taieri during the flood of 1868, that for particular occasions they are of little value. Thus, for the flood of January 28th, a fall of 1·648 in. was shewn, yet that did not raise the Taieri river so much as a fall registered as 1·37 in. did a few afterwards. This, however, does not completely prove the position that the Dunedin register is different from what the Taieri one would be, for it is still possible that the whole area of the gathering ground was not saturated to its fullest extent on the 28th January, so that a greater degree of saturation, as on 4th February, would greatly aid the rain of the latter date in producing a flood greater than the one a few days previous. Better proof, however, is found in referring to the delivery by the river at Outram, which, as recorded by Mr. Thomson, was at the rate of 4,653,068 cubic feet per minute; which would show a fall at the rate of 1·67 in., instead of 1·37, even with the whole water run off to the river just as it fell. Even this, however, is not quite satisfactory, for it is quite possible, and indeed likely, that in both localities there was a space of time—perhaps extending to hours—in which the rainfall was of greater intensity than even the higher of these sums represents. As it is impossible, however, to have the records for each few hours, we must generalize from the most frequent, viz., those for each twenty-four hours.

I shall now endeavour to ascertain the length of time which may be considered as the duration of the flood, or how many hours elapsed between the moment when the banks overflowed, and the outlet to the sea was too small to allow the whole waters which were issuing upon the plain, and the Waipori and Waihola lakes, to pass off.

For this purpose it will be necessary, in the absence of particular data, to assume that the Waipori river and Silverstream delivered their waters at the same rate as the Taieri, in proportion to area; and for the general purpose of this investigation that will be enough. This would show a total outpour from these sources of 5,532,900 cubic feet per minute; and deducting from that amount 1,186,900 cubic feet, which could flow towards the sea, the amount of water which would be dammed back would be 4,548,000 cubic feet per minute, representing the rate of rise of the flood. But it has been ascertained that on this occasion 4,585,996,800 cubic feet were the total flood waters, so that dividing the one quantity by the other we would have a period of flood equal to seventeen and a half hours. Of course, this is to be regarded as simply a hypothetical statement which will represent only the average rise and length of time resulting from that, for it is very likely that the rise would be at this rate only for a few hours, which would consequently necessitate a more lengthened period to produce the same total accumulation from a smaller rate of increase.

We have now to consider the amount of water which it would be desirable to prevent flowing upon the plain by the Taieri river, in order that the floods may not attain to such an extent as to overflow the banks. It has been found that the damage caused about the West Taieri has been the consequence of the small section of the river further down not being sufficient to carry off the whole waters as they arrived; and it has been shown by Mr. Thomson that the smallest section has been able to pass down 1,173,744 cubic feet per minute; but it might not be safe to charge it with even this quantity, so we will leave a considerable margin by taking it only to the extent of 900,000 cubic feet, looking to store the remainder in the Upper Taieri lake, or upon some of the tributaries of the river, such as the Deep, the Sutton, and the Lee streams. It will be observed that this makes no provision for the waters of the Silverstream, or the Waipori river. The first of these could probably be stored in the lagoon near its junction with the main river, and which is evidently the natural flood moderator of that stream, or in some reservoir higher up; while the large flow from the Waipori would be allowed to spread over that and the Waihola lakes. The general result, then, may be arrived at thus:—

	At Feet per Min.
The quantity poured down the Taieri	900,000
,, ,, ,, Waipori	730,000
	1,630,000
Outflow to sea	1,187,000
	443,000

So that the flood, under these conditions, would accumulate at the rate of 443,000 cubic feet per minute, which would spread over the areas of these two lakes, and raise their surface about three feet nine inches in a twenty-four hours flood. Even though there were such a rise, no serious damage would result to the adjoining lands; but in this calculation there are two elements, which are taken at extreme figures, viz., the length of time, and the rate of discharge by the Waipori, which is much in excess of that estimated by Mr. Thomson, so that we may reasonably presume that even under such circumstances as those of the 1868 floods, the rise would be very much less than that I have stated.

The quantity to be stored above Outram would evidently be the difference between the largest flood delivery there in the 1868 floods, and the quantity which I have already named as likely to get past the least capable section of the river, between there and the East Taieri bridge, amounting to 3,200,000 cubic feet per minute. Now this would be derived from different districts, the comparative areas of which are—

	Square Miles.
Above Taieri lake and Kyeburn	850
Sutton, Deep, and Lee streams	480
East of river between Lake and Outram	370
	1,700

But the configuration of the country to the east of the river is unfavourable for storing a large quantity of water upon any of the tributary gullies, and the basin of the Taieri lake is more favourable, so that we must calculate upon having none upon the eastern portion, but store a correspondingly larger amount upon the Taieri lake. Taking therefore three-fourths of the total for that part, and the remaining fourth to be stored in small reservoirs upon the Sutton, Deep, and Lee streams, the Taieri lake would require to have its outlet so raised as to enable it to store as much as 3,002,400,000 cubic feet in eighteen hours. Now the area of that lake and part of the Kyeburn valley which would be affected so far up as the present ford on the Dunedin road is about 91,846,260 square feet, so that the increase of depth would amount to thirty-four feet. This additional depth would be required over the whole area named; but owing to the fall of the valleys, this could not be got on an average without raising the dam to a height above the bank at the bridge, and thus requiring a considerable extension in length. Probably a more economical method might be by a smaller dam at that part, and other two at the outlets from the lake proper, by which means sufficient storage might possibly be obtained for the waters of floods less than that of February, 1868, and also sufficient to reduce a similar one to safe limits, for if they

could be kept back for even twelve hours, their most destructive effects would be moderated. It would also be necessary to have reservoirs upon the Sutton, Deep, and Lee streams, perhaps more so than in the Taieri, in proportion to their areas, as the features of their catchment basins are such as to show many indications of rapid flood-producing streams.

The mode of flood prevention I have examined in this paper is one which has been much adopted upon the continent of Europe, and notably upon the river Loire, which I have already referred to as standing remarkably high as a flood-producer. Above the particular part where the discharge I have referred to was gauged, we have seen that it ranks nearly three times as intense as the Taieri; yet to moderate these waters a weir sixty-five feet high was erected in 1711, which did immense service in the floods of 1846. They topped it, however, by a height of about five feet, but were still sufficiently restrained to lessen considerably the damage which otherwise would have been sustained.

The advantages which the prevention of the flow of the waters upon the lower plain possesses over any scheme of embankment, either along the present channel or any new one, are so evident as scarcely to require remark. Besides being much cheaper, it possesses an advantage in this, that even if carried out to a partial extent it produces general benefit to all the land which has hitherto been liable to inundation; but by the method of embankment upon the plain, intended to shut the water off particular parts, these portions are protected only by aggravating the evil upon other spots, both by the increased depth of the water and the heightened current.

One objection to this method has been so often urged that, paradoxical though it may appear, I believe that had it been founded upon facts, they would, ere this, have been recognized as an argument for its immediate adoption. I refer to the belief that, supposing such a work were erected, the lake would quickly be silted up by tailings derived from the diggings, so that the bottom being raised the weir would speedily become useless. Now the area proposed to be occupied by the reservoir is presently about as much exposed to those deposits as it would be then, and though some parts are so acted upon to a considerable extent, yet had the evil been of such proportions as to be practically felt, a necessity would have existed ere this for the immediate erection of a weir at the outlet, to counteract the shoaling process, and thus prevent a more rapid discharge of the water than would be consistent with its natural condition. An examination of the locality, however, would convince anyone that there is but little to fear from this evil assuming dangerous proportions; for, taking the Naseby diggings alone, it will be seen that even after about nine years of extensive sluicing operations, during which the heaviest flood on record has been experienced, the greatest distance to

which even isolated shingle of large size, or small boulders, have been carried has been about three miles, and they are still about fifteen miles from the lake, and with less chance of making even the same progress again, for the creek becomes flatter as it approaches the low grounds. It will be observed, also, that until the whole lake, up to its lowest water-level, has been filled by solid material, its utility for storing flood waters is unimpaired. I am not in a position to state the contents to that level, but taking its depth at five feet—which I believe to be within the mark—it will be granted, I think, that even with much increased diggings it is safe for many years. If not, then the sooner the outlet is raised artificially the better.

But a real argument for a portion, at least, of this work is to be found in the neighbourhood—from the fact that there are now two outlets from the lake proper, while, before the 1868 floods, there was only one; and also the narrow gorge at the foot-bridge was widened by about an eighth part in the flood of 1870, and from the nature of the strata—being basalt, with very many joints, overlying clay—it is liable to greater extension, and, consequently, to allow the water to come more quickly towards the lower parts and facilitate floods. If it should so happen, in succeeding floods, that the same enlargement of these three outlets should continue, the utility of the lake as a regulating reservoir will be very much reduced; and the more rapid delivery of its waters may almost enable a flood equally as destructive as that of February, 1868, to result from less rain.

ART. XI.—*An Astronomical Telescope on a New Construction.*

By H. SKEY.

(With Illustrations.)

[*Read before the Otago Institute, 19th November,* 1872.]

IF we take a small plane mirror and reflect a parallel beam of light from any distant luminous object, as the sun, on to any fixed point, and then arrange another small mirror close to the side of it, so as to reflect the light from the sun to the same point as the first mirror, and thus proceed to any extent, arranging a number of such mirrors in one plane, so that they shall all reflect the incident ray to the same point, (Fig. 1. *F*), then because the angle of incidence of a ray of light is equal to the angle of reflection, the curved line joining the centres of these mirrors forms the arc of a parabola, and each mirror when so arranged is a tangent to this arc, the surface generated by the revolution of such an arc on its axis being termed a paraboloid.

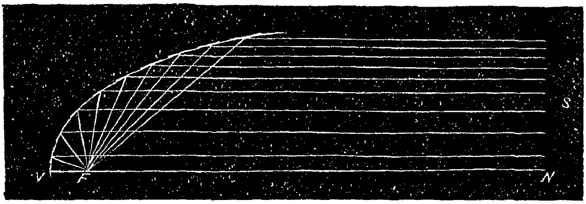


Fig. 1.

As the rays of light from the heavenly bodies may be practically taken as parallel, it is evident that this is the theoretical figure for the specula of reflecting telescopes, for then only can all the rays of light be reflected to one point (*F*).

It will be observed that this curve, near its vertex, approaches to, although it cannot perfectly coincide with, the figure of the sphere.

Now as this curve is a varying one it is clear that no grinding and polishing can mathematically produce the parabolic figure; but as the curve in a sphere is invariable, therefore the spherical figure is first imparted to the ordinary speculum, and this is then modified empirically so that it shall approach to the parabolic figure.

In this manner specula have been constructed whose diameters equal one-sixth of their focal length, but as the parabolic curve rapidly departs from the spherical it is evident that reflecting telescopes of large aperture on the ordinary construction must be of great length and cumbrous in their management. There is also a difficulty in giving them a perfect and durable polish, and then mounting them so that they shall neither be affected by changes of temperature nor deflection of different parts, from their great weight.

The telescope here described has been constructed with a view of surmounting some of these difficulties; its speculum may be said to be cast in Nature's mould, as its figure is determined by the action of those "Laws of Motion," the truth of which were enunciated, and their universality demonstrated by Newton.

Let any liquid be rotated in a vessel, with a given velocity, on an axis which has been adjusted perpendicular to the horizon. After a short time all the forces will be in equilibrium, and the fluid will assume a fixed position. As the surface is free to move, it must, at every point taken upon it, be perpendicular to the resultant of the forces acting upon it at that point.

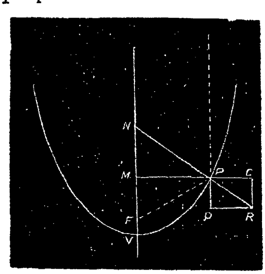


Fig. 2.

Let the curved line (Fig. 2) be a section of the rotating surface made by a plane passing through N V, the axis of rotation.

Let P be any point taken on it. If P M be drawn at a right angle to the vertical axis N V, it is evident that during the motion of the point P will describe a circle in a horizontal plane whose centre is M. In consequence of this circular motion, a centrifugal force will be developed, pressing against

the surface in the direction PC. Let PC represent this force; but P is also subject to another force, namely, its own weight acting vertically downwards, which we may suppose represented by PQ; the resultant of these, therefore, PR, is the whole force acting on P, and so must be perpendicular to the surface, and therefore to the curve. To prove that this curve is parabolic—

$$NM : MP :: PQ : QR \; (=PC).$$

$$NM : MP :: \text{Weight P} : \text{Centrifugal force.}$$

But the dynamical measure of the force of gravity at this latitude is 32·17, expressed in feet every second, and of the latter force $\frac{4\,n^2\,r}{t^2}$ (see note), n representing 3·1416, or the semi-circumference of a circle whose radius is 1, t being the number of seconds in one revolution, and r the radius$=$MP.

$$\therefore \; NM : r :: 32{\cdot}17 : 4\,n^2\,r$$

$$\text{consequently } 32{\cdot}17r \div \frac{4\,n^2\,r}{t^2} = 32{\cdot}17 \times \frac{t^2}{4\,n^2} = 8{\cdot}04\,\frac{t^2}{n^2} = NM.$$

The line NM thus determined is called the sub-normal to the curve at the point P, and when the angular velocity of rotation is constant then the subnormal is also constant in length, no matter in what part of the curve the point P is situated. This property belongs exclusively to the parabola. Hence the surface of a fluid rotating on an axis perpendicular to the horizon is a paraboloid.

To determine then the length of NM for different times of rotation—

Let $t = 1$ second then	$NM = 8{\cdot}04\frac{t^2}{n^2}$	$=$	0·814 feet.
$t = 2$,,	,,	$=$	3·258 ,,
$t = 4$,,	,,	$=$	13·037 ,,

Now that part of a paraboloid where a ray of light parallel to the axis will be reflected along a line forming a right angle to the axis must itself be inclined at an angle of 45°, consequently such reflected ray will, when it meets the axis, have traversed a distance equal to the length of the subnormal, therefore at that part of the curve the two forces, namely gravity and centrifugal force, have the same measure, for they are represented in magnitude and direction by different sides of the same square.

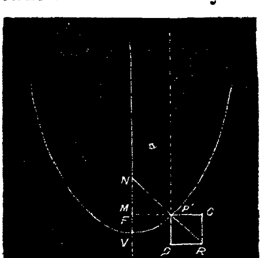


Fig. 3.

Moreover this particular ray is the only one which will be reflected in a horizontal direction along the parameter of the paraboloid until it meets the axis in the focus of the curve. And since the distance FV equals the half FP′ it also equals half NM, by which we can obtain the focal length of the telescope for any velocity.

Within the range of our acquaintance with nature we have one remarkable and brilliant metal which

at ordinary temperatures exists in the liquid state, and we possess in *mercury*, and possibly its amalgams, a surface of imperishable lustre; and, when its equilibrium is established, then its perfection of surface may be safely taken to be such as no human skill could produce upon other metals, for no magnifying power, even that of the most powerful microscope, would be able to exhibit its surface by its irregularities.

In telescopes of this description it is required: first, to construct a circular axis and concentric cup; second, to fix it parallel to gravitation; third, to give it an equable angular velocity. In the model before us will be seen the degree of approximation attained to these requirements. It consists of an upright steel axis about four inches long, the bottom of which rests on a fixed conical pivot, while the upper part (which has been ground circular) is kept in one position by a collar also ground circular. This collar admits of lateral adjustment by screws, which should work on the differential principle. On the top of the axis is fixed a flat disc or cup of beeswax which admits of being easily turned true on the spindle itself, and surrounding this disc is a fly wheel. In working this telescope it is first placed on a fixed base, and then levelled by placing a spirit level across the cup, turning the cup round and adjusting the screws till the bubble remains fixed. The axis is then truly perpendicular, and sufficient mercury is then poured into the cup and rotation communicated to it by any suitable power, in this instance a small electro-magnetic engine, the velocity of which is regulated by a conical pendulum.

We are now enabled to examine the printing placed on the ceiling of this room by magnifying its image, which is formed in the focus, by looking down into the mirror through the eye-piece; although the mirror is rather small for this method of view, as the observer's head cuts off those rays which descend nearest to the perpendicular, and which should consequently give the most distinct definition, the rays moreover are not strictly parallel as they would be if we were viewing a heavenly body, still we are enabled to judge of its capabilities by the definition it gives of these letters. When such an instrument is used for astronomical purposes the observations of course require to be made an object at, or within a few degrees from the zenith, these are always to be preferred for distinctness, on account of the rays traversing the shortest section of the atmosphere, the sweep of the telescope in Right Ascension being made by the earth's rotation.

It may be thought that we are debarred from obtaining a view of any part of the visible heavens at any given time by the use of a horizontal speculum, but such is not the case, for if the rays of light from any celestial body be first received on a large plane mirror at such an angle of incidence that the reflected rays shall descend vertically, such reflected rays will preserve their parallelism, and the paraboloid will collect and reflect them upwards to the

eye-piece through an aperture left in the plane reflector. This is perforated to allow of a small telescope or finder to be used, or the finder can be placed at the side of the mirror as in Fig. 4. Let both plane mirror and finder have a vertical motion on a horizontal axis common to both, then since "the angle between the first and last direction of a ray of light suffering two reflections in the same plane, is twice the angle of the reflecting surfaces to each other," and because the first direction of the ray is the same as the finder, and the last direction is towards the zenith, it follows that the angular motion of the finder must be twice that of the plane reflector; this is easily accomplished, and in such a manner that by merely turning the finder on to an object the reflector shall move through its proper angle.

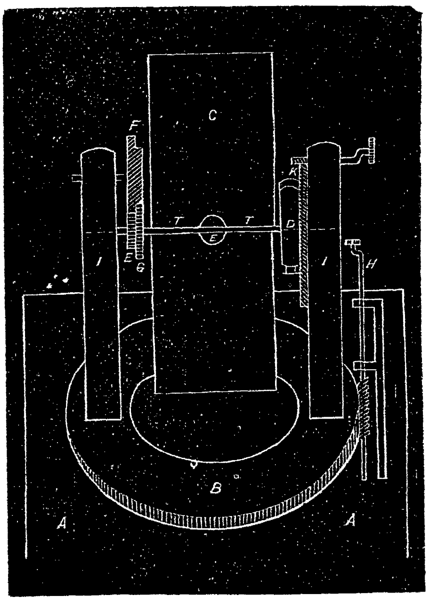


Fig. 4.

Let AA (Fig. 4) represent a platform fixed above the speculum, H is a rod working an endless screw which turns a horizontal racked wheel, B, rotating on rollers running in grooves between the platform and the wheel. This wheel carries the pillars II, consequently the mirror, C, and the finder, D, move in azimuth with equal velocities. The mirror is firmly braced on to the tube, TT, which carries with it the wheel, E, and E turns another broad wheel, F, which turns with the same speed as E, for that part of it which receives motion from E is equal to E. The other part of F has such a diameter as will give a motion to the wheel, G, of double the velocity of E. The ratios of the diameters of these wheels are E = 6, small part of F = 6, large part of F = 8, and small wheel G = 4. The dotted line represents a strong rod or axis, which also goes through the tube T. To this axis the wheel, G, and the finder, D, are firmly keyed. The finder is attached to, and moved in altitude by another racked wheel, also turned by an endless screw, K; then, whatever angular motion in altitude is imparted to the finder, the mirror shall receive one-half thereof. The eye piece is fixed near E, and is supported by connection with the pillars so as to be independent of any vertical motion of the mirror.

Such an arrangement gives the same degree of illumination as is given by the Newtonian telescope, there are two reflections, with this difference, that the light from the object is first received on the plane mirror instead of on

the concave one, and thus by simply turning the plane reflector on its axis we are saved the cumbrous alternative of moving the whole tubular length of the telescope in order that it may point to the object to be observed. In large instruments this must be a very important desideratum. Let us suppose a telescope twenty feet in diameter: ordinarily this would require tubing at least 120 feet in length, and provision would be required for its sweeping through 300 feet of motion; whereas with the horizontal speculum, a circular building thirty feet in diameter and about sixty feet high would furnish ample space, and also allow the observer, without changing his position, to work entirely under shelter.

In such an instrument the friction is reduced to a minimum by perfecting the bearing of a single axis, consequently little power is required for continuing its rotation.

I may remark that I have used, with good effect, the regular flow of water through a small turbine, in order to impart to the speculum an equal angular velocity. By merely altering the velocity we are enabled to shorten or lengthen the telescope, and in a few seconds the mercury attains its equilibrium, and not only the parts near the vertex are parabolic, but those also which extend to the parameter, and to any distance we like to go above, leaving out of consideration a very slight deviation caused by the earth's sphericity, which would impart a slight tendency to the hyperbolic curve, but which, even in immense instruments, would be so minute as to be within the power of correction by the eye-piece of the telescope.

It also follows that the focus can be observed by looking upwards, if the vertex of the curve be removed, and those parts only used which are above its parameter.

As it is of immense importance that we should be able to concentrate a large beam of light for examination of the distant nebulæ, and especially for spectroscopic investigations, it is not improbable that the use of such an instrument, constructed on a large scale, would extend our knowledge of the natural heavens, for notwithstanding all the discoveries made in the great cosmic problems of creation, still, that we may be enabled to travel further into what is as yet the dark profound, and to gaze with bodily eye on what now form the manifold mysteries of the universe, must be the ardent wish of every lover of science.

NOTE.—That the above expressions are the dynamical measures of gravity and centrifugal force is thus shown:—

In circular motion the centripetal and centrifugal forces are everywhere *equal.* Let the arc AB be described in one second; draw BE perpendicular to AS; then in one second the body originally at A will have fallen from its wonted straight path, AM, a distance = AE towards the attractive force at

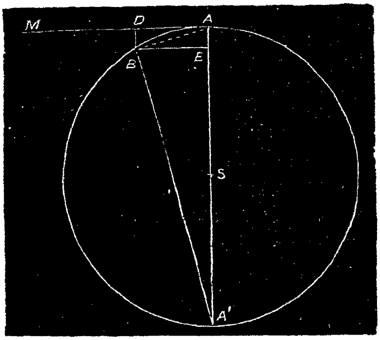


Fig. 5.

S; and because a uniformly accelerating force is measured by twice the space described from rest in one second, and it is found by experiment that the force of gravity on the earth's surface causes a body to fall from rest a distance of 16·1 feet in the first second of time, consequently the force of terrestial gravity $g = 32 \cdot 2$ feet, that is, this force continuously soliciting a falling body, will accelerate its velocity 32·2 feet every second; therefore 2AE expresses the intensity of gravity acting on A. Join BA; then since the arc AB differs insensibly from its chord (for the time of describing it may be made as small as we please) we may regard ABA′ as a right angled plane triangle since the angle B is in a semicircle, therefore AE : AB : : AB : AA′.

$$\therefore \mathrm{AE} = \frac{\mathrm{AB}^2}{\mathrm{AA}'} = \frac{\mathrm{AB}^2}{2\mathrm{AS}} \therefore 2\mathrm{AE} = \frac{\mathrm{AB}^2}{\mathrm{AS}} = \frac{v^2}{r}$$

Now 2AE represents the accelerating force at S, or taken in an opposite direction, it represents the centrifugal force f, and AB represents the velocity v in the curve; consequently the centrifugal force $f = \frac{v^2}{r}$, where r = radius. If, as is usual, n be made to stand for the number 3·14159, etc., the whole circumference of the circle will be $2nr$; therefore calling the whole time of describing the circumference—that is the periodic time, t—then the uniform velocity v being equal to the whole space divided by the whole time we have—

$$v = \frac{2\,n\,r}{t}, f = \frac{4\,n^2\,r}{t^2},$$

$$\text{for if } v = \frac{2\,n\,r}{t} \text{ then } \frac{v^2}{r} = \frac{2\,n\,r}{t} \times \frac{2\,n\,r}{t} \div r = \frac{4\,n^2\,r}{t^2}.$$

Deviation from the parabolic figure arising from the earth's sphericity only amounts to $\frac{1}{871200}$ of an inch at the circumference of a speculum four feet in diameter.

ART. XII.—*Description of a Reflecting Telescope made in Wellington by W. F. Parsons.* Communicated by JAMES HECTOR, M.D., F.R.S.

[*Read before the Wellington Philosophical Society, 23rd October, 1872.*]

THE instrument which I exhibit is a Newtonian model, with a silvered-glass speculum, and with the exception of the eye-pieces has been wholly made in Wellington by following the directions given in a paper by Mr. W. Purkiss,

in the "English Mechanic," Vol. 10, pp. 208, 330 and 357. The diameter of the reflecting speculum is $5\frac{7}{8}$ in., and the focal length 4 ft. $9\frac{3}{4}$ in. The total length of the tube, which is made of galvanized iron, being 5 ft. 9 in., and its diameter $6\frac{1}{4}$ in. The telescope is mounted on an equatorial counterpoise stand, with simple rack motion worked by hand, and on clear nights gives definition up to 300 diameters. The instrument was constructed in spare time, extending over eighteen months, but the real time employed if it was steadily worked at would occupy about six weeks. A second instrument, on the same principle, but with a 9 in. speculum, and 7 ft. focus, has also been constructed with the same machinery by Mr. J. Widdup, the speculum of which is also exhibited. The chief portion of the time was occupied in making the speculum, the remainder of the work being of an ordinary mechanical character. In making the speculum there are five distinct processes: rough-grinding, fine-grinding, polishing, parabolizing and silvering.

(*a.*) The first step is to construct an iron tool having the required curvature, the model from which this is cast being made in the following manner:—With a radius of double the length of the proposed focus curved gauges or templates were cut in zinc, from which the wooden model is turned, and the casting made. The tool was then fixed firmly on an upright pillar, and covered with coarse emery powder. The glass for the speculum, which in this case was originally the side light of a steamer $\frac{3}{4}$ in. thick, was then fixed to a board and laid on the tool with a 28 lbs. weight on the top, and ground by a pulling and pushing motion round the pillar until it conformed to the test of the convex gauge.

(*b.*) *Fine Grinding.*—To effect this the surface of the convex iron tool was cut by cross grooves which divide its surface into squares, the object of which is to diffuse the fine emery evenly over the surface, and so produce accuracy of figure. Before proceeding, however, the curve of the tool was perfected by what is termed file-testing. A few drops of coloured oil were first spread on the surface of the rough ground speculum, which was then laid gently on the tool so as to leave a mark on those portions which required filing—a delicate process, which had to be repeated over and over again till every part of the surface of the tool was equally marked with the oil. Before proceeding to fine-grind the speculum it was necessary to make what is termed the test-bar, to be used in an after process. This is a slip of cardboard, with parallel edges fixed on a rod, the surface of which is made accurately to fit the curve of the speculum. To proceed with the fine-grinding the tool and speculum were mounted on a machine contrived so as to give four distinct motions:—1. A slow rotation to the grinding tool. 2. Direct back and forward stroke. 3. A transverse stroke. 4. Free rotation to the speculum on its own axis. This machine is a cheap, but quite serviceable, form of that which was designed by

Lord Rosse for grinding his metallic speculum. Flower emery was used for fine-grinding, made into the thickness of cream with water, and spread evenly over the surface of the squares into which the surface of the tool was divided. The machine was then driven at about sixty revolutions per minute, the emery that escaped being collected, washed, and precipitated. This process was repeated four times, a finer degree of emery being obtained by allowing it a longer time to settle in each instance; the last time the emery being so fine that it took twenty-four hours to settle from the water, which was then drawn off by a glass syphon. When the fine-grinding was completed the surface of the speculum looked like plate-glass covered with a milky film, no grain being visible with a magnifying glass.

(*c.*) *Polishing.*—To effect this the iron tool was faced with pitch $\frac{3}{4}$ in. thick, divided into squares by grooves in a similar manner to the iron tool itself. The soft surface of the pitch when warm was moulded by the glass speculum so as to fit correctly, and then covered with rouge purified from grit by washing and settling in the same manner as the emery. The polishing was then done on the same machine as the fine grinding, and occupied six hours of continuous work, so that no change in the form of the pitch surface should take place through great alteration of temperature. The utmost care had to be exercised to prevent any dirt settling on the tool during this part of the process.

(*d.*) *Parabolizing.*—The curve of the speculum produced by the above process was such that on being mounted on the tube it gave imperfect definition. To correct this, and to give the surface the perfect curve, was the most important and delicate part of the whole process, and formerly was effected only with great difficulty. The use of the test bar already alluded to, which is the invention of Mr. Purkiss, enables it to be done with comparative facility. The strip of cardboard was fixed with the curved wood on the face of the speculum. A star was then viewed with the eye-piece out of focus, so as to get an enlarged disc of light crossed by a black band caused by the test-bar. The edges of this band were found to be curved instead of straight, and all that was required to produce a proper curve was to modify the polishing surface of the tool by repeated trials until it imparted such a form to the speculum that the image of the test bar had parallel edges. This was done by scraping down the squares of the pitch on the surface of the tool so as to make them proportionally larger or smaller, at the centre or margin, as experience required. By this simple process a correction of the curve amounting to only one-millionth of an inch can be made.

(*e.*) *Silvering.*—The speculum having been thus polished to a true curvature could be used for observation in the same manner as a metallic speculum, but there was, of course, a great loss of light owing to the transparency of the glass.

To obviate this the reflecting surface was covered with an extremely delicate film of pure metallic silver by what is termed Browning's process, produced by the decomposition of nitrate of silver by sugar of milk. After a few trials on another glass surface this process was successfully applied to the speculum, when the silver film having been polished to a fine surface by a wash-leather rubber and fine rouge, the speculum was ready for mounting. The mounting requires to be very accurate in order to give equal support so as to avoid the slightest flexure of the glass, but this was effected in a very simple manner by laying it on six freely-balanced points so arranged as to give equal support.

ART. XIII.—*On the Influence of Change of Latitude on Ships' Compasses.* By Captain EDWIN.

[Read before the Wellington Philosophical Society, 6th November, 1872.]

IN all calculations concerning the magnetic character of ships, several co-efficients are used; of these, five, namely, from A to E, are used to ascertain the approximate value, and the corresponding letters of the German alphabet are used to obtain the exact values: these co-efficients enable us to compute the alterations that take place on change of magnetic latitude, and enable us to compute and correct excessive deviations, and also the heeling error or the new magnetic character which becomes developed as the ship leans over. This error is due to vertical induction in soft iron, and though well known to exist is, except in vessels of war, taken but little notice of. It is most important, as the change in deviation due to its influence is very great, it having been found that, even in most carefully placed compasses, a vessel may have when upright an easterly deviation, but an inclination of a few degrees may change it to westerly; this shows at once that, unless this peculiarity is allowed for, it will seriously affect the position of the ship.

Suppose an iron ship is coming to Wellington from Lyttelton, and that soon after leaving port a fair wind comes off the land, and being of good strength it leans the ship over, it is evident that iron which was before horizontal now becomes inclined and thus becomes magnetized by induction, the upper ends becoming north poles; these poles now attract the south end of the compass needle, and consequently it approaches the higher side of the vessel, and the north point drops towards the lower side. The helmsman, who we will suppose has been told to steer north, finding that the vessel's head is not in the given direction, brings the north point ahead again, and the result is that instead of making the desired course the vessel is steered to that side of it toward which the north point has dropped, and the captain finds that the vessel is not in the position he intended, but not being aware that this is the effect of heeling error

he probably considers it to be the result of inattention on the part of the helmsman. One of the greatest difficulties which the navigator of the present day has to contend against arises from the magnetic changes which take place in iron-built ships on every change of latitude, especially in places where the dip of the needle or magnetic latitude varies rapidly. These changes affect the compass in a proportionate amount, and in cases where no special care has been observed in the selection of a place for the compass by which the ship is navigated the changes in the deviation become a source of great anxiety to the mariner. It appears to me that considerable advantages in this respect would arise from the increased employment of steel-built ships. During the process of building the common iron-built ship becomes highly magnetised by induction, but does not become a really permanent magnet—it has more the properties of what is termed sub-permanent magnetism. A vessel built of steel must, however, become a permanent magnet during the process of building, and I think there would be much less change in the magnetic character of this vessel than in the one built of iron, because the changes would be due to hard iron only, while in the iron ship it arises from both hard and soft iron. In the case of the steel ship the change takes place in the inverse ratio of the horizontal force, while in the vessel built of iron the change arises from this, and is also for soft iron in the ratio of the dip. In this colony there is a difference of about ten degrees of magnetic latitude between Auckland and the Bluff, and as the soft iron is the part most affected by change of latitude it is evident that if it is of considerable amount its effect upon the compass will be marked. I will now suppose that the co-efficients have been found for a vessel at the Bluff, and that $A = -1°$, $B = +15°$, $C = -6°$, $D = +3° \ 30'$, $E = -0° \ 30'$, and that it has been ascertained that there are $+3°$ to be allowed for vertical induction in soft iron, then at Auckland B will have decreased to $+5° \ 42'$ and C to $-4° \ 30'$, and the deviations of the compass from which the co-efficients were obtained will have decreased at North 1° 46′, at N.E., 5° 28′, or half a point, and at East, 9° 18′, or very nearly seven-eighths of a point; and if the vessel was steered to make an east course near Auckland, using the same deviation as at Bluff, the result would be that the vessel would be directed nearly one point too much to the southward, which would, in so short a distance as five miles, cause an error in the assumed position of one mile, or twenty per cent. in the estimated distance. I have omitted all notice of heeling error in this instance, which, as already shown, may be such as to very seriously interfere with the navigation of the ship if guided by an uncompensated compass. The Government steam vessel "Luna" being built of steel enables me to bring forward a case in point. The co-efficients of this vessel have been ascertained from observations made in Auckland by Mr. Stewart, C.E., whose ever careful work I am glad of an opportunity of

acknowledging. In this vessel the co-efficients are very small, $A = -1° 17'$, $B = -0° 31'$, $C = +3° 31'$, $D = +6° 50'$, $E = +0° 25'$, and, assuming that any change is due only to the influence of hard iron, I find that the greatest difference in deviation due to change of magnetic latitude between Auckland and the Bluff amounts to only 2° 32′, or a fourth of a point nearly; this occurs on the N.W. point, and in a run of five miles would place the vessel about one-fifth of a mile to westward of its true position. It must, however, be thoroughly understood that no soft iron should be so placed as to influence the compass of the steel vessel. The changes due to difference of magnetic latitude, and also to heeling error, have brought a great feeling of distrust as to the compensation of compass errors by magnets into the merchant navy. This arises partly from no warning as to the existence of such changes being certain to take place having been given to shipmasters, and partly from their not having been cautioned that compensation by magnets is not intended to eliminate all compass errors, but only to bring them within such limits as may render navigation more easy. Something may also be due to erroneous compensation, and thus it has happened that after a vessel had got some distance upon her voyage the courses steered did not produce the desired effect, and the magnets have been considered the prime cause of the ship not being in the place to which the courses steered should have carried her. Compasses are, in the merchant navy, frequently placed with the most utter indifference as to the position and amount of the adjacent iron, and this will be found to be the case in both wood and iron-built ships; compensation in such cases is useless, as from the influence of soft iron the deviations are continually changing in value. It is with a view to the correction of this indifference that the Board of Trade now require every candidate for examination as Master to answer certain questions as to the effect of iron on the compass-needle, with the hope that the result will be in time that masters of vessels will attend to the placing of the compasses in more effective positions, and I hope that in a few years the important effects due to deviation, heeling error, and change of magnetic latitude, will be so well understood that it will be a matter of some difficulty to obtain a captain for any vessel which has not at least one compass placed with due regard to the magnetic character of the ship. In small vessels it is a matter of great difficulty to place the compasses properly, but there can be very little in placing them so that they may be much more reliable than is often the case at present.

ART. XIV.—*On Barata Numerals.* By J. T. THOMSON, F.R.G.S.

[*Read before the Otago Institute, 22nd July,* 1872.]

THE great insular languages of the Torrid Zone I have shown in a previous paper* to have been originally derived from an archaic negro race occupying the peninsula of Hindostan, anciently termed the country of Barata. The language of this archaic negro race was there shown to have extended from Madagascar to Easter Island. As I have, since I wrote the former paper, had an opportunity of comparing the numerals of thirty-four off-shoots of the above archaic and wonderfully expansive race, I now beg to submit to our Society the remarks and observations that have occurred to me, and from which I derive certain conclusions, which will have the weight due only to the very narrow limits of inquiry and imperfect materials available to me.

Taking the aboriginal numerals of New Zealand, viz., the Maori, as the basis of our comparisons, it will be found, on referring to the annexed table (see p. 137) that this basis would equally serve for any or all of the great Polynesian groups, their numerals being radically the same with the above, such as the Cocos, Friendly, Society, Marquesas, and Sandwich Islands, even to the remote Easter Island. Comparing the numerals of that remote and distantly disjoined island at the westerly extreme of expansion of the great Barata race, viz., Madagascar, the curious fact will appear that out of the ten numerals only one is dissimilar, and only so far as the dissimilarity consists in a convertible consonant; the root of the numeral "one," in which the sole dissimilarity takes place, being in Maori, *ta* (*tahai*)†; Malagasi, *sa* (*essa*); and it will be seen in comparing this numeral in the intermediate races of the Eastern Archipelago and adjacent groups that this dissimilarity equally obtains, some races adopting the dental pronunciation of the Maori, others the sibilant pronunciation of the Malagasi. Thus, in the first essay to count, one of the most distant and important races of the human family has been divided at centre and extremes.

* See *Trans.* N.Z. Inst., Vol. V., Art. I., p 23.

† As phonography differs in various parts of New Zealand, I carefully weighed the question of spelling the Maori numerals, and decided on the forms here used as affording the best illustrations for my paper. The usual spelling, as given in Williams' dictionary, is as follows:—*tahi*, one; *rua*, two; *toru*, three; *wha*, four; *rima*, five; *ono*, six; *whitu*, seven; *waru*, eight; *iwa*, nine; *ngahuru*, ten; *tekau*, eleven.

As an illustration of the above facts, quotations are given in the following table from various vocabularies :—

English Numeral, "One."

Tahai ...	Maori.	Essa or isso	Malagasi.
O Eeutu ...	Ceram.	Sa or satu	Malay.
Tika ..	New Guinea (coast).	Sye ..	Lampong... } Sumatra.
Ret Tee ...	Tanna.	Sada ...	Batta ... } Sumatra.
Taci ...	Horn Islands.	Sigi ..	Java.
Taci ...	Isle of Cocos.	Ysa ..	Tagala ... } Philippines.
A Tahau ...	Friendly Islands.	Isa ...	Papango ... } Philippines.
Tahe ...	Sandwich Islands.	Isa ...	Mindanao .. } Philippines.
Tahi ...	Society Islands.	Isse ...	Savu (Timor).
A Tahe ...	Marquesas.	Osu ..	Papua (New Guinea).
Ko Tahe ...	Easter Island.	Esa ...	Rotti (Timor).
Ita ...	Kissa ... } Timor.	Mesi ...	Coepang (Timor).
Ita ..	Tenimbar ... } Timor.	Su ...	Keh (Timorlaut).
Itu ...	Arru.		

Some of the races have a radically different numeral, such as *ji*, Kayan (Borneo) ; *hijee*, Prince's Island (Sunda); *sigi*, Java ; *kaou*, Isle of Moses ; *parai*, New Caledonia, etc.

The numeral "two" is expressed by a word radically the same by all the Barata races ; the following of which are examples, showing their variations, such as :—*rua*, Maori ; *rua*, Malagasi ; *dua*, Malay ; *lorou*, Java ; *dalova*, Tagala ; *o'looa*, Ceram ; *wa roo*, New Caledonia ; *looa*, Friendly Islands ; *E rooa*, Otaheite ; *bo hooa*, Marquesas. Divergence from the above rule is limited, and of which the following are examples :—*Etji*, Vialo (Timor) ; *woror*, Kissa ; *bore*, Tenimbar.

The numeral "three" is radically similar in all the races, with the exception of Malay and some in Melanesia and the Timor group, as the following examples will demonstrate :—*torou*, Maori ; *tulloo*, Malagasi ; *tloo*, Acheen ; *tulloo*, Lampong ; *toloo*, Batta ; *tellou*, Rejang ; *tallu*, Prince's Island ; *tullu*, Java ; *ytlo*, Tagala ; *atlo*, Papango ; *tulu*, Mindanao ; *tulloa*, Savu ; *o toloo*, Ceram ; *toloa*, Isle of Moses ; *tolu*, New Guinea (coast) ; *tolou*, Horn Islands ; *tulou*, Isle of Cocos ; *toloo*, Friendly Islands ; *toorou*, Island of Amsterdam ; *torhoa*, Society and Sandwich Islands ; *toroo*, Otaheite ; *a toroa*, Marquesas ; *toroo*, Easter Island.

Examples of radical divergences are as follows :—*tiga*, Malay ; *kior*, Papua ; *wat een*, New Caledonia ; *ekei*, Malicolo ; *ka har*, Tanna ; *utue*, Vialo ; *wokil*, Kissa ; *lasi*, Arru, etc.

The numeral "four" has wider acceptance than the numeral three, being similarly expressed by all races, excepting two in Papuanesia and three in the Timor group. The following are examples of the form of expression in its variations :—*t'fa*, Maori ; *efar*, Malagasi ; *ampat*, Malay ; *paat*, Acheen ; *ampah*, Lampong ; *oput*, Batta ; *m'pat*, Rejang ; *opat*, Prince's Island ; *pappat*, Java ; *apat*, Tagala ; *apat*, Papango ; *apat*, Mindanao ; *uppu*, Savu ; *opatoo*, Ceram ; *wati*, Isle of Moses ; *putta*, New Guinea (coast) ; *ebats*, Malicolo ;

ka fa, Tanna; *d'fa*, Horn Islands; *fa*, Isle of Cocos; *t'fa*, Friendly Islands; *a'faa*, Amsterdam Island; *ha*, Otaheite and Sandwich Islands; *a faa*, Marquesas; *fa*, Easter Island; *pat*, Kayan (Borneo), etc.

Examples of radical divergences are as follows:—*tiak*, Papua (New Guinea); *par bai*, New Caledonia; *wo ahka*, Kissa; *ka*, Arru, etc.

By reference to the table the number "five" will be seen to have the most extensive diffusion of any in a radically similar expression, there being only one exception to this. The following are examples of the above numeral:—*reema*, Maori; *limi*, Malagasi; *lima*, Malay; *lumung*, Acheen; *leema*, Lampong; *leemah*, Batta; *lema*, Rejang; *limah*, Prince's Island; *limo*, Java; *lima*, Tagala; *lima*, Papango; *lima*, Mindanao; *lumee*, Savu; *o leema*, Ceram; *rima*, Isle of Moses; *lima*, New Guinea (coast); *rim*, Papua; *wan nim*, New Caledonia; *e reem*, Malicolo; *ka rirrom*, Tannah; *lima*, Horn Islands; *lima*, Isle of Cocos; *neema*, Friendly Islands; *neema*, Amsterdam Island; *h lemi*, Sandwich and Society Islands; *a aeema*, Marquesas; *reema*, Easter Island; *lima*, Rotti; *limi*, Vialo; *walima*, Kissa; *wa lima*, Tenimbar; *au lim*, Keh; *lima*, Arru, etc. The sole exception is in Coepang, *ni* being the expression.

The number "six" is another of the most widely diffused under a similar expression. The common form with variations will be seen to be as follows:—*onê*, Maori; *onê*, Malagasi; *anam*, Malay; *annam*, Lampong; *onam*, Batta; *noom*, Rejang; *num*, Acheen; *anim*, Tagala; *anam*, Papango; *anom*, Mindanao; *unna*, Savu; *eno*, Isle of Moses; *onim*, Papua; *houno*, Isle of Cocos; *vano*, Friendly Islands, *whaine*, Sandwich and Society Islands; *a ono*, Marquesas; *honoo*, Easter Island; *anam*, Kayan; *wanam*, Kissa; *walem*, Tenimbar; *annam*, Keh. The radical exceptions are *gunnap*, Prince's Island; *o loma*, Ceram; *hovw*, Horn Islands; *ne*, Rotti, etc.

The Maori expression for "seven" is not so generally diffused as that for six, yet it, with its variations, is the general rule among the Barata races. The following are examples:—*wheetoo*, Maori; *feetoo*, Malagasi; *peetoo*, Lampong; *paitoo*, Batta; *petu*, Java; *pito*, Tagala; *pitu*, Papango; *petoo*, Mindanao; *petoo*, Savu; *o peeto*, Ceram; *fitu*, New Guinea; *fitou*, Isle of Cocos; *fidda*, Friendly Islands; *hitoo*, Sandwich and Society Islands; *a wheetoo*, Marquesas; *heedoo*, Easter Island; *hitu*, Rotti; *hi it*, Coepang.

The radical exceptions are:—*tudju*, Malay; *toojoo*, Acheen; *toojoon*, Rejang; *tudju*, Prince's Island; *tik*, Papua; *tusyu*, Kayan; *wo iko*, Kissa; *wa ite*, Tenimbar; *au fit*, Keh; *duhem*, Arru.

To the Maori expression for "eight," the same remarks apply as to seven, as may be seen by the following examples:—*warou*, Maori; *varlo*, Malagasi; *ovalloo*, Lampong; *ovallou*, Batta; *wolo*, Java; *valo*, Tagala; *valo*, Papango; *walu*, Mindanao; *arvo*, Savu; *o aloo*, Ceram; *wala*, New Guinea; *war*, Papua; *walou*, Island of Cocos; *varoo*, Friendly Islands; *wallhoa*, Sandwich and

Society Islands; *a wavo*, Marquesas; *varoo*, Easter Island; *jalu*, Rotti; *ju'au*, Coepang, etc.

The radical exceptions are:—*delapan*, Malay; *d'leppan*, Acheen; *delapoon*, Rejang; *delapan*, Prince's Island; *saya*, Kayan; *kafar*, Vialo, *wo ah*, Kissa; *karua*, Arru, etc.

There is the same degree of accordance in the expression of the numeral "nine" that there is in seven and eight, as the following examples will show:—*eeva*, Maori; *seeva*, Malagasi; *seewah*, Lampong; *seeah*, Batta; *siyam*, Tagala; *siam*, Papango; *seaow*, Mindanao; *saio*, Savu; *siva*, Isle of Moses; *siwa*, New Guinea; *siou*, Papua; *yerou*, Isle of Cocos; *heeou*, Friendly Islands; *iva*, Society and Sandwich Islands; *a eeva*, Marquesas; *heeva*, Easter Island; *siu*, Rotti; *seu*, Coepang; *siwa*, Vialo; *wa siawa*, Tenimbar; *au siu*, Keh.

The exceptions are as follows:—*sambilan*, Malay; *sa koorong*, Acheen; *sembilan*, Rejang; *salapan*, Prince's Island; *songo*, Java; *o teeo*, Ceram; *pitan*, Kayan; *wohi*, Kissa; *teri*, Arru.

The number "ten" is nearly as common to all the Barata races as the numeral five, and it is only in the Timor group that radical differences take place, as will be seen from following examples:—*Anga hourou*, Maori; *fooloo*, Malagasi; *sapuloo*, Malay; *saploo*, Acheen; *pooloo*, Lampong; *sapoo loo*, Batta, *de pooloo*, Rejang; *sapoulo*, Prince's Island; *supoulo*, Java; *pulo*, Tagala; *apalo*, Papango; *san poulo*, Mindanao; *singooroo*, Isle of Savu; *o pooloo*, Ceram; *sanga poulo*, Isle of Moses; *sanga foula*, New Guinea; *on ge foula*, Isle of Cocos; *ango fooroo*, Friendly Islands; *houlhoa*, Sandwich and Society Islands; *whanna hoo*, Marquesas; *atiu hooroo*, Easter Island; *sanga hulu*, Rotti; *pulo*, Kayan.

The radical exceptions are:—*ho es*, Coepang; *ta ana*, Vialo; *ita weli*, Kissa; *aluli*, Tenimbar; *wut*, Keh, etc.

It will be seen that in numerals radically similar the variations have been principally caused by the conversion of sibilants, dentals, aspirates, and palatals into each other, or by the dropping of the whole, the vowel sounds remaining radically alike.

In the general view of the question, as elucidated by the facts before us, it will at once be observed that the numerals of the most distant races and the more remote interior and uncivilized tribes of the Eastern Archipelago are the most similar. Thus, admitting that the sibilant is convertible into the dental, as *ta* into *sa*, the Maori and great groups of far Eastern Polynesia have numerals identical with the great island of Madagascar. A remote race in the interior of the great island of Sumatra, viz., the Lampong, has numerals identical with Maori; while another in the same island, viz., the Batta, has numerals identical with the Malagasi—the former adopting the dental, the latter the sibilant. Again, the numerals of the principal races of the Philippines, viz.,

Tagala, Papango, and Mindanao, are identical with the Malagasi, which is also the case with the island of Savu, near Timor, and Dory, in New Guinea.

What do these facts, as far as they go, tend to prove? This; they serve as another proof to the theory that I have already advanced from other data, that one tropical race, a negro one, had in archaic times power and vitality to extend its off-shoots and language from the centre, *i.e.*, Barata (ancient Hindostan) westward as far as Madagascar, and eastward as far as Easter Island; and that the most remote branches of the race should now speak languages more similar than those near the centre is consistent with what ethnological inquiry teaches us to have taken place in the Eastern Archipelago, viz., that the languages in that middle distance between the extremes of migration have been affected (though not radically) by the incursions of Arian, Thibetan, and other continental races.

It will thus be seen that the numerals of one archaic race have extended over 200° of longitude, a distance only surpassed by the transcendent efforts of the modern British, and as the Malay race has come in intimate comparison with their predecessors (the Barata) by their having occupied a portion of the middle distance, viz., between 100° and 140° of longitude, and though limited to 40°, or one-fifth of the space, yet, it being a very important part, some allusion is necessary to estimate the nature of their connection, if any exists. On reference to the table, it will be seen that of the ten numerals five only of the Malay are similar to the Maori, and six are similar to the Malagasi. This removes the Malay to the same distance from the archaic numerals, as those of the Timor and Arru groups, geographically connected rather with Australia than the Eastern Archipelago; such being the case the connection is but very distant.

Some of the ruder tribes, such as those of New Caledonia, Malicolo, and Tanna, will be seen to only count as far as five, and this, in prehistoric times, seems also to have been the case with the archaic Malay. Such was his crude advancement in the science of figures; so we may conclude that while the Malay was a rude savage in the interior of Sumatra, the Barata race occupied the Malacca Strait—the gate of Africa, India, and Polynesia—and advanced to the height of his power and expansion till the inroads of the Arian and Thibetan extruded him from his peninsular seat and eliminated his race and language from the country of his origin.

The first six numerals, excepting the third, will be seen to be almost identical in all the races of Madagascar, the Indian Archipelago, and Polynesia. In Malay the numeral three, or *tiga*, entirely differs from these, and the sixth may have been derived from the Barata term, which has been universally adopted by the adjacent tribes, viz., the Acheens, Lampongs, Battas, and

Rejangs. But the next three numerals, viz., seven, eight, and nine, in Malay, are not Barata, but of their own invention, adopted at a time when the rise and progress of the tribe demanded the addition, and the manner of invention may be explained as follows:—Seven is expressed by *tudju*, that means to point which act is done by the seventh, or forefinger of the right hand after the left had been counted. Eight is expressed by *delapan*, that is *dua lapang*, or two spaces between it and the last, or tenth, finger (the small finger of the right hand). That this is the correct interpretation is proved by another language in Sumatra, viz., that of Prince's Island, which uses the same term for eight and *sa lapan* for nine, that is one space between it and the last; while the Acheenese for the same numeral (nine) use *sa korong*, *i.e.*—one wanting. Nine is expressed in Malay by *sambilan*, *i.e.*—one count from the last. This idiom is common to the language, thus, for example, "half-past three" they express by saying "half of four o'clock." Ten is expressed by the word *sapulo*, that is *sa-ulo*, or one end or head, the "p" being inserted for the sake of euphony, a very common practice in the Malay language.

Thus we see that of all the numerals in the table the Malay, in common with remote Timor, has borrowed least from the Barata tongue, and so far as the evidence goes, it has had little connection with the origin of the Polynesian languages, including that of New Zealand. This I adduce as another proof of the theory I have previously advanced on other data before this Society.

With the extinction of the Barata power there arose the Malayan influence, but which extended, in its most palmy days, only from Sumatra to Ternati. Its original seat in the highlands of Sumatra, viz., Menangkabau, by its fertility and temperate climate, was well fitted to develop a race superior in energy to those found on the sea boards and enervating plains of the Malayan Peninsula and adjacent districts. The proximity of the river outlets of Menangkabau to the Straits of Singapore, the key of eastern navigation, placed the Malay race (once developed into a nation) in a strategical position eminently superior to the only powerful nations that could come in contact with them, viz., the Siamese and Javanese. The whole basin of Malacca must be described as barren, so the region, while being the key to the Archipelago, can only be said to be fitted for trade or piratical adventure. In these pursuits we find, from native history, that the Malays competed with the Bugis over the length and breadth of the Archipelago, drawing down on themselves the intermittent wrath of the kings of Kalinga, Siam, and Java.

Marco Polo visited their capital, at that time fixed at Singapura (Singapore) in the year 1292, a valuable date, a desideratum of which native histories are entirely deficient, for by this we may estimate the chronology of

TABLE SHOWING DEGREE OF SIMILITUDE IN BARATA NUMERALS.

MAORI OR NEW ZEALAND	Malay	Mala. isl.	SUMATRA. Achin	Lampong	Batta	Rejang	Prince's Island, Sunda.	Java.	PHILIPPINE. Tagala	Pampango.	Mindanao.	Savu (Timor)	Ceram.	Isle of Mysol	Dory (New Guinea)	Papua (New Guinea)	New Caledonia.	Mallicollo.	Tanna.	Horn Islands.	Cocos	Friendly Islands.	Sandwich Islands.	Society Islands.	Marquesas	Easter Island.	Kayan (Borneo).	TIMOR. Rotti	Coepang.	Vitlo	Kissa.	Teniimbar	Keh.	Arru.
. Tahai ..	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0		—		—				—	—	0	0	0	0	0	0	0	0
2. Rua	—	—	—	—	—			—	—	—									—	—	—		—	—	—	—	—	—	—	0	0	0	—	—
3. Torou ...	0	—				—	—	—	—	—	—	—				0	0	0	0	—	—	—	—	—		—	—	—	0	0	0	0	0	0
4. T'Fa ...						—	—	—		—	—	—		—		0	0		—	—	—	—		—	—	—	—				0	0		0
5. Reema	—	—	—	—	—		—	—	—	—	—			—			—		—	—	—	—		—	—	—	—	—	0	—	—	—	—	—
6. Oné ..			—	—			0	—	—			—	0	—	—	—				0	—		—	—					—	0		0	—	0
7. Wheetoo .	0	—	0	—	—	0	0	—	—	—	—	—	—		—	0					—	—	—	—	—	—	0	—	—	—	0	—		0
8. Warou .	0	—	0	—	—	0	0		—	—	—	—		—							—	—	—	—		—	0	—	0	0		0		0
9. Eeva ...	0	—	0			0	0	0		—	—			—	—	—					—	—	—	—		—	0	—	—		0		—	0
10. Anga Houron	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				—	—	—	—	—	—	—		—	0	0	0	0	0	0
Numerals same as Maori	5	9	6	10	9	6	5	8	9	9	9	9	8	9	9	6	2	4	4	6	10	10	10	10	10	10	6	9	5	4	3	3	7	2

NOTE.—Sign "—" signifies similar; sign "0" different.

concurrent, prior, or succeeding events. These I have sufficiently touched on in my former paper, and therefore need not do so here.

Thus I hope I have satisfactorily shown that the first ten numerals, in as far as their evidence is valuable, tend to prove the intimate connection that subsisted between an archaic race that spread over nearly two-thirds of the circumference of the globe—and in which expansion the Malay had no connection—but the ethnological phenomenon was due solely to the illustrious Barata.

For the native numerals I am indebted to the labours of Captain Cook, Windsor-Earle, and Burns.

NOTE.—Since the above was written I have had an opportunity of perusing the vocabulary of numerals given at the end of Mr. Wallace's admirable work on the Malay Archipelago. The vocabulary is confined principally to the Molucca and adjacent groups, and is entirely confirmatory of my previous observations.

The vocabulary is of thirty-three languages or dialects, and in regard to the numeral one, 23 belong to the archaic Barata; of the numeral two, 29; three, 27; four, 30; five, 31; six, 28; seven, 28; eight, 21; nine, 27; ten, 14.

It has already been stated that the Malay numerals three, seven, eight, and nine differ from the Barata and its offshoots, and in this vocabulary only one tribe is found to copy the Malay in the numerals three, eight, and nine, while only two tribes copy it in the numeral seven; another proof of its slight claim to its generally received paternity of Polynesia and Madagascar.

ART. XV.—*Notes on the Stone Epoch at the Cape of Good Hope.**

By B. H. DARNELL.

[*Read before the Wellington Philosophical Society, 28th August*, 1872.]

SOME new facts have turned up respecting this subject within the last year or two. Diamonds were first found on the surface over a large area. Then followed the diggings in the beds of rivers and their banks; these are the wet diggings. Then diamonds were found in the diorites and amygdaloids where these swell up into what are called "koppies," small round hills like heads (Dutch *kop*), these are the dry diggings. Lastly they were found in the "Pans," which are reed-bound circular depressions in the surface, filled with limestone (mainly carbonate of lime) a few feet in thickness. These Pans are quite a feature in this part of the country, and generally hold water after the rainy season. In them fragments of ostrich shells, stone implements,

* See *Trans.* N.Z. Inst., Vol. IV, p. 157.

earthern vessels, etc., have been found by the diggers imbedded in the calcareous deposit. Some, whose opinions are entitled to respect, consider it probable that these relics found their way into the hollows at the same time and in the same manner as the broken and perfect diamonds have done, and that the accumulation was a work of time and great climatic changes; and that the diamonds were not found where they are now found, but have come from some other source. The sagacious editor of a newspaper, in commenting upon these views in a leading article, remarks:—"We cannot say that we agree with this judgment. The diamonds are strangers in the chalk beds at Du Doit's Pan and De Beer's, but they are scarcely much older strangers than the ostrich eggs and broken pots."

He was, perhaps, nearer the mark than he imagined when he wrote this. For how old may these ostrich eggs and broken pots not be? The ostrich, I imagine, is older in Africa than the Moa is in New Zealand, geologically speaking, and then it is not yet extinct.

Dr. Atherstone, a geologist of some repute, says, "But though some surface diamonds no doubt, along with ostrich eggs, arrow heads, bones, etc., got down these cracks to a considerable distance, it does not follow that all Bultfontein diamonds were thus accumulated. Wind may have blown sand and pebbles, and even diamonds in, but there are other sections and facts which cannot be thus explained."

Daintree says (I don't think he has seen a "Pan") "The Du Toit's Pan *kalk* is evidently a secondary deposit, as it contains abraded fragments of quartz, garnet, etc., and besides has 86 per cent. of carbonate of lime, soluble in hydrochloric acid. I have just seen a diamond attached to this *kalk*, which certainly looks, under the microscope, very much as if it had crystallized *in situ*, showing no sign whatever of abrasion, and having small cavities on the surface corresponding with the structure of the *kalk* matrix to which it is attached. This specimen shows me that Bunn's theory of the diamonds being blown into the Du Toit's Pan material can only hold for a moiety of such gems, and will, I almost think, account for very few. Why should they be blown into cracks in the *kalk*? Why not into any cracks between that and their source, and in that way it should not be difficult to find out their source? We must, in this matter, 'wait a little longer.'"

I have sent to the Cape for all the pamphlets which have been published on the diamond field, in the hope that some further light may be thrown on the subject.

ART. XVI.—*On the Flight of the Black-backed Gull* (Larus dominicanus). By Captain F. W. HUTTON, C.M.Z.S.

[*Read before the Auckland Institute, 19th August*, 1872.]

THE phenomenon of flight has of late years attracted considerable attention, and the subject has been very fully and ably discussed, especially by Dr. Pettigrew, of London (*Trans.* Lin. Soc., 1868, p. 197), and Professor Marey, of Paris (*Smithsonian Report*, 1869, p. 226). Both these authors have been very successful in explaining the flight of insects, but considerable obscurity seems still to exist as to the actual movements of the wings of birds when flying. Mr. Macgillivray (*British Birds*, Vol. I., p. 34) said that the effective stroke of the wing is delivered downward and backward, and suggested that during the down stroke the resistance of the air bends upward the free tips of the feathers, and the reaction thus produced gives a forward impulse to the bird. The Duke of Argyll (*Reign of Law*, p. 132, 1867) and Professor Marey both hold a similar view, but while the former maintains that the effective stroke is delivered directly downward, the latter says that his experiments prove that during the down stroke the wing moves first slightly forward, then more and more backward; and in the up stroke at first backward, and then forward into its original position again. Dr. Pettigrew on the other hand asserts that the effective stroke is delivered downward and forward, and that by a peculiar twisting or screwing motion of the wings, which I confess I do not quite understand, the air is forced to escape near the root of the pinion, between the secondary and tertiary feathers, in a downward and backward direction, thus by its reaction supporting the bird and driving it forward.

Professor Marey again says that during the greater part of the down stroke the wing, by turning on its axis, slopes forward and downward, while during the up stroke it slopes forward and upward, thus being on this point quite opposed to Dr. Pettigrew, who states distinctly that during the down stroke no depression of the anterior margin and elevation of the posterior one takes place. Dr. Pettigrew, and the Duke of Argyll also, both say that during flight the point of the wing describes a "wave track," or simple undulating line through the air, while Professor Marey says that his experiments show conclusively that it describes a more or less regular cycloidal curve, or looped line. All four authors, however, agree that the wing is extended during the down stroke, and more or less folded during the up stroke. Under these circumstances a few observations that I have made on the movements of the wings of the common black-backed sea-gull during flight may prove of interest, for not only do they point to a theory of progression much simpler than any

hitherto proposed, but they also supply an explanation of many of the differences between other authors, and this curiously enough by showing that they are mistaken in the only point on which they are all agreed, viz., the folding of the wing during the up stroke.

Before, however, describing my observations, I will mention some of the very interesting experiments made by Dr. Pettigrew on the flight of sparrows, with their wings cut in different ways, which, in my opinion, not only annihilate, as he says, Mr. Macgillivray's theory, but his own also.

From his experiments I pick out the following as the most decisive.

1. Half of the secondary feathers of both pinions detached in the direction of the long axis of the wing, the primaries being left intact. *Result.*—Flight perfect.

2. Half of the primary feathers in the long axis of either pinion detached, the secondaries being left intact. *Result.*—When one wing only was operated on flight was perfect, when both were cut it was slightly laboured.

3. Primary and secondary feathers from both wings removed alternately. *Result.*—Flight nearly perfect.

4. Half the primary feathers from either wing removed transversely. *Result.*—When one wing only was operated on flight was but very slightly impaired, when both were cut the bird flew heavily and came to the ground at no great distance.

These experiments prove that cutting the wings in the direction of the long axis interferes very little with flight, but that if the tips of the primaries are cut off transversely the effect is very evident. This, in other words, means that flight depends principally on the primary feathers of the wing, and not on the secondaries, while both Mr. Macgillivray's and Dr. Pettigrew's theories imply quite the reverse, for the former says that progression is obtained by the uplifting of the secondary feathers, and the latter by the secondary feathers forming a kind of funnel which compels the air to escape in a backward direction. Dr. Pettigrew himself (*l.c.*, 245) says that "the bending up of the shafts of the feathers during the descent of the wing would impair its efficiency by permitting more air to escape along its posterior, or thin margin, than is necessary;" much more, therefore, ought its efficiency to be impaired by cutting off the shafts of the feathers. But experiment proves clearly that such is not the case.

There is no better time for observing the movements of the wings of a bird than when at sea, steaming against a fresh breeze, and surrounded by a flock of sea-gulls. Under these circumstances the birds often appear to be quite stationary, sometimes straight overhead, sometimes astern, and sometimes on one or the other quarter, so that distinct views from below, from the front, or from one side, can be obtained, while the movements of the wings of

the gull are so slow that the eye can easily follow them. An attentive examination will convince anyone that the wings are moved from the shoulder straight up and down, or very nearly so, that the elbow joint is not appreciably bent during either stroke, but that during the down stroke the wrist joint, which bears the primary feathers, is bent back, and expanded again during the up stroke. While, therefore, the movement of the main part of the wing from the shoulder is nearly vertical, the tips, by having also a horizontal movement, do not describe a simple "wave track" in the air, but a cycloidal curve as stated by Professor Marey.

I should, not, however, omit to mention that Dr. Pettigrew, who also says that flexion occurs principally at the wrist joint, states that while watching rooks he has, over and over again, satisfied himself that the wings are flexed during the up stroke. The rook, however, cannot be compared to the gull in affording facilities for observation. It cannot be seen so near; it moves its wings faster, and it never occurs under those circumstances just mentioned, when the bird, although flying through the air, appears to be stationary, sometimes for more than a minute at a time. Still, I must allow that confirmatory evidence is necessary to others before they can accept my statement as correct, while at the same time such evidence would be very satisfactory to me.

If, however, I am correct in stating that this backward, or rowing motion of the primaries, is delivered during the down stroke, it is obvious that it is this that drives the bird forward, easily, therefore, explaining the results arrived at in the previously mentioned experiments, viz.—that when the primaries are cut flight is stopped, but that when left intact it is but little impeded, although the secondaries are cut off.

It is also obvious that, in order to preserve a steady line of flight, it will be necessary to expose a greater surface of the wing to the air while it is being raised than while it is being depressed, in order that it may support the bird by its kite-like action, as I have explained in my previous paper on the flight of the albatros (*Trans.* N.Z. Inst., II., 230). The truth of this has been proved by the experiments of Professor Marey, who has shown that during each complete vibration of the wings, a bird rises and falls twice successively, but that these oscillations are unequal in extent, the greater corresponding to the depression of the wings, and the lesser to their elevation; this latter being caused by their kite-like action just described.

From an anatomical examination of the wing, Dr. Pettigrew states that "during flexion the anterior margin is slightly directed downwards, and in extension decidedly directed upwards." This is just what we should expect if flexion takes place during the down stroke, and it will then agree with Professor Marey's experiments; and it is, I think, entirely from supposing that flexion must necessarily occur during the up stroke that has led Dr.

Pettigrew to the extraordinary opinion that the *forward* movement of a bird is derived from a stroke delivered downward and *forward*.

Dr. Pettigrew, and many other authors, hold the opinion that the wing feathers of a bird open and close during the up and down strokes respectively. But however this may be with birds that only flap their wings slowly, it is, I think, almost impossible that such rapid changes should take place in the wings of a bird like the sparrow, which, according to Professor Marey, makes thirty-three vibrations per second. Dr. Pettigrew's experiments, also, upon the sparrow, with alternate feathers taken out of the wing, show that an opening and shutting movement is not necessary for flight; and we may safely assume on the principle of greatest economy of force, a principle always acted upon throughout nature, that what is not necessary is not used.

The falconers of olden days were well aware that rapidity of flight depended on the primary feathers of the wing, and they called these the "flight feathers," while the secondaries they called the "sail feathers," and it will be found that the swiftness of a bird's flight depends on the length of the primaries in proportion to the size of the bird, and on the number of strokes it makes per second. Thus the swift, which has proportionately longer primary feathers than any other bird, is probably the fastest flier, while the partridge, which has broad wings but short primaries, flies heavily, and has to make very rapid strokes. The wild-duck has less area of wing in proportion to its weight than a partridge, but its primaries are longer, and consequently it flies much faster. The landrail also is another example of a slow-flying bird with considerable expanse of wing for its weight, but with short primaries. The heron also furnishes another instance of the same kind, and it is well known that the long winged falcons are far superior fliers to the round winged buzzards, vultures, and eagles, although in the latter the area of wing surface is probably greater than in the former.

The way in which birds turn in the air has also been much misunderstood. Professor Owen (*Comp. Anat. of Vert.* II., 115) advances the extraordinary theory that when a bird wishes to turn it beats the air more rapidly with one pinion than with the other, which however originated with Borelli in his "*De Motu Animalium*."

Van der Hoven (*Handbook of Zoology*, II., 371) also reiterates the same opinion, while Macgillivray (*l.c.* I., p. 420) says that turns are effected by the contraction of one wing and the extension of the other, aided by the tail.

The real method of turning, however, is very simple, and was, I believe, first pointed out by me in the *Ibis* for July, 1865, p. 297. It must be remembered that when a bird is flying the reaction of its wings against the air is not only forward but also upward, the latter being necessary to counteract the force of gravity. If now a bird lowers its right side, so that the axis from

the breast to the back, which was before perpendicular, is now inclined to the right, part of the upward reaction will be diverted to the right, and will therefore turn the bird in that direction. Of course the force thus diverted will be taken from that necessary to counteract gravity, so that the bird would fall if it did not compensate for this loss by increasing the angle to the horizon at which it was flying. So that if a bird wishes to turn to the right all it has to do is to elevate the left and lower the right side of the body, and at the same time elevate the fore and lower the hinder parts of the body; if it wishes to turn to the left, it will elevate the right and fore parts, and lower the left and hind parts, and the sharpness of the turn will depend entirely upon the angle that the wings, or rather the line drawn from tip to tip of the wings, makes with the horizon. This movement may be easily seen in the pigeon, gull, pheasant, or indeed in almost any bird.

Art. XVII.—*On Compound Engines.* By William Lodder.

[*Read before the Auckland Institute, 19th August, 1872.*]

The engines of the "Star of the South," as originally fitted, were inverted, low pressure condensers of the ordinary type, with cylinders of 22 inches diameter and 18 inch stroke; nominal horse-power about 27; they were manufactured by Hawthorne, of Newcastle-on-Tyne, in 1863.

In June of last year the boiler was found unfit for much further use. It then became a matter for consideration what kind of boiler should be adopted, and it was finally determined to put in a small multitubular circular boiler, capable of sustaining a working pressure of 80 lbs. per square inch at sea; also to compound the engines and introduce a surface condenser.

It was calculated that by adopting this plan a saving in fuel of one half would be effected, the speed of the vessel remaining the same as before.

Plans and specifications were prepared by Mr. James Stewart, C.E., at whose suggestion the compound principle was adopted, and the contract for the new machinery and alterations was carried out by Messrs. Fraser and Tinne, of Auckland, in a highly creditable manner.

For the benefit of owners of steamers and others unacquainted with the method of conversion of single into compound engines, it may not, perhaps, be out of place to explain more fully the plan adopted, because nearly every screw steamer running on the coast of New Zealand could be similarly converted, and with equally good results.

The engines were compounded simply by the addition of high pressure cylinders, of 9 inches diameter, fixed above the existing cylinders, the piston

rods being lengthened to enable both pistons of high and low pressure cylinders to be fixed on one rod, while the same pair of eccentrics were arranged to work the valves of the upper and lower cylinders of each combined engine. The steam from the upper cylinders exhausts into the valve chest of the lower cylinders, exerting its remaining pressure in them. It then escapes into the surface condenser, whence it is conveyed back again to the boiler in the shape of fresh water at a temperature of about 135° Fahr.

Both of the old air-pumps are brought into use, one as a circulating pump to force the water through the tubes of the condenser, the other to operate in the usual way. By this system two separate compound engines are made, using the same condenser.

The high-pressure cylinders are steam-jacketed, as also are the covers of the lower cylinders and the exhaust pipes leading from the upper cylinders to the lower ones. There is also an interheater placed in the lower steam chest between the slide valves to assist in keeping up the tension of the steam. The supply of steam for the jackets is taken from the superheater at a temperature probably of 350° Fahr.

The surface condenser is cylindrical, and contains 735 brass tubes, four feet long and five-eighths of an inch outside diameter, giving a cooling surface of 465·5 square feet, the tubes being fixed into brass tube plates with screwed glands and indiarubber washers.

The boiler is 7 ft. 3 in. in diameter by 9 ft. long, having two furnaces 2 ft. 2 in. by 6 ft. There is a superheater with the uptake passing through it, and the total heating surface, including the superheater, is 502·56 square feet.

These combined engines are of 38·8 horse-power, by Watt's rule, and 45 nominal horse-power by the Admiralty rule; the ratio of cylinder areas is as 6 to 1 nearly, all four cylinders cutting off at three-quarter stroke, so that the steam is expanded about eight times.

On the trial trip the boiler pressure was 80 lbs. per square inch, and the diagrams taken by Mr. Stewart, Government Inspector of steamers, showed an initial pressure of 72 lbs. per inch; mean pressure 61·75 lbs., and the terminal pressure, 37·5 lbs.; average number of revolutions per minute 80, indicating 58 horse-power for the upper cylinders.

The effective pressure in the lower cylinders was only 7·6 lbs., indicating 42 horse-power, making a total of 100 indicated horse-power for the combined engines, with a consumption of 376 lbs. per hour, or 3·76 lbs. per indicated horse-power per hour.

The diagrams also showed that the steam in the lower cylinders is under atmospheric pressure, hence the smallness of the power in them as compared with the power given out in the upper cylinders. There ought to have been at least from 5 to 6 lbs. above the atmosphere in the lower cylinders.

Another important matter in connection with these engines is a loss of from 8 to 40 lbs. of steam between the boiler and the engines. The writer is at present unable to account for so much loss as this, unless the steam pipes be too small.

Since the trial trip a number of indicator diagrams have been taken, and these show, without the supplementary steam jet, a positive pressure on the lower cylinders of from 2 to 3 lbs. per inch; the deficiency is at present about 3 lbs., lost from condensation of the steam passing from one cylinder to the other, and filling up the steam passages in the lower cylinders.

The fact of not having any steam at or above atmospheric pressure in the lower cylinders at first, must be attributable to the steam jackets and interheater not working properly, probably through some of the cones being left in the upper cylinders, or from some other obstruction in the steam-jacket pipes.

COMPOUND ENGINES. A.										C.				
Departure from Auckland.	No. of Hours on Passage.	Departure from Napier.	No. of Hours on Passage.	Total No. of Hours on Voyage.	Average Boiler Pressure.	Mean Pressure. Top Cylinder.	Mean Pressure. Lower Cylinder.	Revolutions per Minute.	Vacuum on Gauge.	Indicated Horse-power. Top Cylinder.	Indicated Horse-power. Lower Cylinder.	Coals Consumed. Per Voyage.	Coals Consumed. Per Hour.	Coals Consumed. Per Indicated Horse-power per hour.
					lbs.	lbs.	lbs.		in.			Tons.	cwt.	lbs.
Dec. 30	50·5	Jan. 4	71	131·5	80	...	...	80	24	...	...	27·6	4·2	..
Jan. 11	59	,, 16	75	134	77	62·5	10·65	78	24	56	51·2	27·5	4·2	4·3
,, 22	57	,, 26	60	117	77	...	...	79	24	...	..	24·6	4·2	4·3
,, 30	50·5	Feb. 3	59	109·5	76	...	...	78	24	...	...	23·42	4·28	...
Feb. 9	59·5	,, 13	53	112·5	76	62·8	10·65	78	24	56	51·2	24	4·28	4·3
,, 21	48·5	,, 26	51·5	100	78	...	...	78	24	...	...	21·4	4·28	...
Mar. 1	59	Mar. 6	59	118	78	...	...	78	24	..	...	25·2	4·28	...
,, 12	71·5	,, 20	54·5	126	77	...	...	77	24	...	...	26·9	4·28	...
,, 25	62·5	,, 29	67	129·5	77	...	...	77	24	...	...	27·7	4·28	...
April 3	54·5	April 8	66	120·5	78	...	...	78	24	..	...	25·78	4·28	...
,, 20	48·5	,, 24	94·5	143·5	78	...	...	..	24	...	...	30·7	4·28	...
May 4	61·5	May 8	58	119·5	77	...	...	...	24	...	...	25·5	4·28	...
,, 13	47	,, 17	60	107	78	...	...	...	24	...	...	22·89	4·28	...
,, 21	54·5	,, 25	70	124·5	...	...	..	...	24	...	...	26·2	4·28	...
OLD ENGINES. B.										D.				
1871.		1871.										Tons.	cwt.	lbs.
		Mar. 3	61	61								21·6	7·09	7·94
Mar. 8	58	,, 12	87	145								51·4	7·09	...
,, 26	60		...	60	It is assumed that the old engine worked up to 100 indicated horse-power, as there was no counter fixed or means of taking diagrams.							21·29	7·09	..
Apr. 13	56·5	Apr. 19	54	110·5								39·17	7·09	...
,, 25	57	May 1	56	113								40	7·09	...
May 6	66	,, 11	69	135								47·85	7·09	..
,, 17	52	,, 23	71	123								43·6	7·09	...
,, 31	60	June 6	60	120								42·8	7·09	...
June 13	55	,, 17	68	123								43·6	7·09	...
,, 24	54	,, 29	59	113								40	7·09	...
July 5	47	July 10	62	109								38·6	7·09	...

The Tables on page 146 will show at once the comparative results of the two systems in point of economy and speed. Tables A and B are an extract from the ships' log by the chief officer; they show in the first place the average number of hours on the passage each way.

It will be well to notice a coincidence between Tables A and B in point of time on the down trips. Table A gives an average with the compound engines of 56 hours for the down trips from Auckland to Napier, and 64·17 hours for the up trips from Napier to Auckland—thus making the down trips in twelve per cent. less time than the up trips.

In working out the averages in Table B, very nearly the same result occurs. The down trips made with the old engines took 56·5 hours, and the up trips 64·7, being twelve per cent. quicker on the down trips, the same as with the compound engines. The result gives for Table A one per cent. in favour of the compound engines in point of speed, taking the average of five months' running.

Table C shows the consumption of coals with the compound engines for the voyage per hour. Table D shows the same for the old engines.

On comparing C and D we find a saving in fuel of 42·1 per cent. with the compound engines, and this, with the increase of one per cent. in speed, requires for its attainment three per cent. more power.

This consumption does not include the coals used for banked fires, cooking purposes, or steam winch. I have made the same deductions for Table D as for Table C for these purposes.

With regard to the general working of these engines up to the present time there is every reason to be satisfied. Certainly there has been one source of annoyance, and that has been the excessive priming, actually in some instances taking the water right through the engines into the surface condenser; but since the addition of another steam dome on the boiler, connecting it with the superheater, the excessive priming has ceased, but the water still rises in the gauge-glass several inches above its true level. I find from inquiries that this is the case, more or less, in all boats using surface condensers, even with low-pressure steam.

Before going into the various questions that arise with reference to priming, the chemical and electric actions of the steam and water on the boiler, I shall endeavour to show by comparison, theoretically, the superiority of the compound principle. I have stated my belief that nearly every screw-steamer on the coast of New Zealand could be similarly converted, and with equally good results. Supposing we take two examples with a similar class of engines, to those in the "Star of the South," but much larger—say one of the steamers now plying on the coast (s.s. "Phœbe"), of which I have been furnished with dimensions of engines, consumption, etc. We have to find from the data

given, first, the approximate indicated horse-power ; the quantity of water to be evaporated to supply the engines at a given speed and pressure, with a given known consumption. Secondly—To calculate in the same way the results that would probably be obtained if the same engines were converted into compound engines.

This seems to be a subject of importance to every one concerned or interested in the use or science of steam, but it must not be understood that I pretend to satisfactorily solve the question of the superiority of the compound principle, but to bring it before the notice of this Society for discussion.

At the same time I shall endeavour to show the results of a few simple calculations from the three different examples given.

Commencing then with the before-mentioned examples of engines, whose cylinders are 44 inches diameter, with a piston speed of 297 feet per minute, and an initial pressure of 15 lbs. on the square inch, cutting off at $\frac{5}{8}$ of the stroke, and a mean vacuum of 26 inches, the consumption of coal being 18 tons per 24 hours, or 15 cwt. per hour. Working this out in the usual way, these engines might be expected to indicate 7·11 horse-power, and the quantity of water that would have to be evaporated to supply the engines at the above-named pressure and speed is 241 cubic feet per hour. This is equal to one pound of coal evaporating 10 lbs. of water in the hour, or a consumption of 2·36 lbs. per indicated horse-power per hour.

Secondly.—We will now compare the above results with what would probably be obtained if these engines were compounded with two high-pressure cylinders (similar to those in the "Star of the South") of 22 inches diameter, with a boiler pressure of 80 lbs. per inch, and cutting off at half-stroke in all the cylinders. Still retaining the same piston speed, we shall have for the upper cylinders an initial pressure of 75 lbs. per inch, the mean pressure 63 lbs. The initial pressure in lower cylinders being 9·375 lbs., the back pressure in upper cylinders will be 54 lbs. per square inch, and the ratio of expansion in upper cylinders being 2 to 1, the terminal pressure equalling 37·5 lbs., from which data, using the same formula as in the preceding examples, the two high pressure cylinders would indicate 372·4 horse-power.

The ratio of the areas of the upper and lower cylinders being 4 to 1, the initial pressure in lower cylinders will be say 9·3 lbs., cutting off at half-stroke ; mean pressure = 7·6 lbs., but deducting 3 lbs. for loss of steam travelling from one cylinder to the other, and condensation, we shall have a total effective pressure of 4·6 + 13 = 17·6 lbs. in lower cylinders, which will give 481 horse-power for the lower cylinders, making a total of 854 horse-power for the combined engines, and this with the steam expanding eight times to one.

The quantity of water required to be evaporated to supply the engines at the speed and pressure above stated will be 165 cubic feet per hour ; allowing

then the same quantity of coal to evaporate the same number of pounds of water (same as in the first example) this will give a consumption of 8·9, or say 9 cwt. per hour, with an increase of power equal to 143 horse-power more than in the preceding example, and the consumption would be 1·2 lbs. per indicated horse-power per hour.

Taking this then as a purely comparative statement, it shows an increase of power and at the same time nearly 50 per cent. saving of fuel. It must not be taken to mean that these calculations which leave out many sources of loss of heat and force, are likely to be attained in practice in any altered engines, but the least result of 1·2 lbs. per indicated horse-power per hour has been surpassed by compound engines.

It has been stated by some that equally good results could be obtained with using high-pressure steam in single cylinder engines, and cutting of at a fractional portion of the stroke. There are objections to this plan; for instance, in expanding the steam say 6 to 1, as in the other cases, the terminal pressure would be very great, and totally lost as far as exerting any power is concerned, unless it was a very long stroke, and this for screw-engines is impracticable; besides, the vacuum would not be nearly so good, and there would be more loss by condensation than with compound engines.

The compound engine uses the steam down to its very lowest pressure, and none is lost, except a little by condensation, and this can be reduced to about 1·5 lbs.

From what has been advanced it will be seen that there can be little doubt of the superiority of the compound engine in point of economy over the old system with low pressure steam and jet condenser. There is not such a low consumption per indicated horse-power with the "Star of the South's" engines as is stated to be got on the trial trips at home from some of tl large boats, but the surest test is, when knowing the consumption and speed of a certain vessel with the old system to compare the obtained results after conversion, as has been done in the "Star of the South's" case, and a saving in fuel proven, of 42·1 per cent., after six months running, with no diminution in speed, but an increase of one per cent., as shown by the above tables; and no doubt even a better result would be obtained with new compound engines than by converting old.

If we consider the two theoretical examples given we find a very small consumption per indicated horse-power. There is no doubt but a very great saving could be effected in a vessel of the class selected.

We now come to some of the disadvantages of using surface condensers and high-pressure steam; and first, with regard to priming, it is one of the phenomena of ebullition, and occurs more or less in all boilers using surface condensers, whether with high or low pressure steam, irrespective of the kind

of engine. By mechanical means its action can be greatly retarded and kept within safe limits, but I do not think there is at present any known remedy for its perfect prevention.

In using surface condensers the same water is being continually converted into steam and reconverted into water. Has this anything to do with lifting the water above its true level? Is there a large, or any, portion of the air extracted with this continual distillation?

Secondly.—The effect of using surface condensed water and high-pressure steam in the boiler is to destroy the plates of the boiler, either by galvanic action or from some electrical influence. I am inclined to believe more in the former because we have the brass tubes of the condenser and the copper pipes forming the negative pole, and the boiler and hot well forming the positive pole, the sea water circulating in the condenser and used to supplement the feed, forming a saline solution as a medium. On leaving out the zinc plates for a few trips, streaks of black oxide of iron were discovered about the superheater, and other parts in the boiler, especially where the greatest heat was. The superheater was cleaned and painted, and zinc plates replaced in the water space of the boiler. Since then no injurious effects have taken place.

Another strange phenomenon is the deposition of a calcareous substance thrown against the top of the shell of the boiler as if one were to take a handful of mortar and throw it against the wall, but these deposits only require removing about once in two months. Since leaving off the use of tallow for lubricating the cylinders these deposits on the upper part of the shell are scarcely noticeable.

I must not forget to mention another important matter in reference to the preservation of the boiler, especially where exposed to the action of the steam, viz.,—the application of Portland cement, put on in the same way as white-wash; it is the best preservative that I am acquainted with, and I am indebted to Mr. James Stewart, C.E., for this hint.

In conclusion I may state that some persons imagine that compound engines are complicated. This is not so; neither is there any difficulty in starting or stopping them. When we find boats of 3,000 tons steaming 10 knots on a consumption of 18 tons per 24 hours it speaks well for this class of engine. The "Adriatic," the largest steamer afloat next to the "Great Eastern," has compound engines, and has just made the quickest trip across the Atlantic on record. There is nothing whatever to prevent any of the steamers running on the New Zealand coast from being compounded, with results equal to those here stated, and it is also satisfactory to know that there are special facilities for converting them in Auckland.

ART. XVIII.—*Notes on Rurima Rocks.* By Major W. G. MAIR.

[*Read before the Auckland Institute, 23rd December, 1872.*]

THIS group of islets, situated about four miles from the main land and five or six miles north-east from the entrance to the Awaateatua river in the Bay of Plenty, presents many interesting features, and would, I believe, well repay a careful examination. In the early part of 1871 I visited them during a fishing excursion, and as nothing, I believe, has ever been written about them, it has occurred to me to jot down, as well as my memory serves, these few notes.

Unlike most islands or rocks on the New Zealand coast this group stands on a shallow patch, and the shores, instead of being steep-to, present a margin of rock or sand extending in some parts to a breadth of 150 yards between high and low water-mark. This formation breaks the sea, and prevents that weather-beaten appearance so characteristic of sea-girt islets. The most western islet (Rurima proper) is about 100 feet in height; it covers an area of perhaps four acres, and consists of three hummocks placed in the form of a triangle, with one of its points presented to the north and another to the west. The western hummock is insulated at high water, the other two are connected by a belt of light sandy soil about seventy yards broad, and not more than ten feet above high water. On either side of this belt is a sand beach, the western one forming a landing in southerly and easterly winds, if the sea is not heavy; while that on the eastern side, protected as it is by rocks on either hand, forms a bay, with good landing in almost any weather with wind from north nearly round to south. There is hardly water enough for anything larger than ten or fifteen tons to use this bay as an anchorage in heavy weather. The first mentioned hummock is the smallest, it is precipitous and densely covered with the ordinary littoral plants. The one forming the southern corner of the angle is lower, and flat-topped, with a growth of short fern. The heat imparted to the soil by an old fumarole has made this mound a favourite breeding place for many varieties of gulls.

Under favourable conditions of the atmosphere steam may be seen issuing from the ground in several places, but it is evident that the igneous action is all but extinct.

The northern hummock is the largest and highest in the group; it is thickly wooded, and possesses some fine specimens of pohutukawa (*Metrosideros tomentosa*), in some of which I observed nests of the common pied shag (*Graculus varius*). The only fresh water in the group is on the north-west face of this hummock. It is a dripping spring not many yards above high water-mark, nearly hidden by the arching roots of a huge, half prostrate

pohutukawa; the water is slightly brackish, and very limited in quantity. The Maoris have a tradition that if anyone were to lie down at length and drink from the pool the waters would straightway dry up. An old chief who accompanied us to point out the best fishing grounds charged each member of the party to be careful and *dip* the water. It was with much pleasure that I listened here to the sweet note of the koromako (*Anthornis melanura*). I have heard it occasionally on Whale Island, about five miles from Rurima. The Maoris think that it is the sole survivor of the race and that it flies backwards and forwards between the islands.

The other islet, Moutoki, lies about half-a-mile to the north-east. It is perhaps 150 yards in length by 50 in breadth. It is on a cone-like hummock rising from its centre that the tuatara (*Sphenodon punctatum*) is found; the area of this cone is not more than half an acre, and yet the tuatara exists and has existed for ages in this limited preserve. Tradition says that they were plentiful on Whale Island, but does not account in a satisfactory manner for their extinction. If, as the Maoris aver, their ancestors ate all kinds of lizards, how is it that they are so frightened of them? In a few minutes we caught four tuataras (the largest of which I forwarded to Mr. Kirk); they were found basking on the rocks and in holes in the loose soil. Whether these holes were the burrows of sea birds or had been scraped by the lizards I could not tell. In one instance we found a tuatara and a young penguin in the same burrow. The Maoris, as a rule, have a perfect horror of lizards, and associate them with death or disaster, but a couple of Urewera lads, who formed part of my crew, proved superior to superstitious influences, and pulled them out bravely, receiving, however, sundry sharp nips for their temerity. It is believed by some that the tuatara feeds for a portion of the year at least on the eggs of sea birds, but I could never coax one to eat an egg. From an examination of their excreta I am of opinion that their food consists of insects, more particularly a shining black beetle, about half-an-inch in length, with a longish neck, small head, and fluted clytra; it is commonly found under stones and old wood. On the summit and sides of the cone I noticed the pohutukawa, one or two pittosporads, the common fern, some aspleniums, and a well-known grass; about the base there is a thick growth of a dwarfed coprosma (*C. lucida* in all probability). This part of the islet swarms with a small, dark, mottled brown lizard, half-a-dozen of them under every stone or bit of drift-wood. As far as I could discover, they never mix with their larger brethren on the cone. While on this subject, I may mention the existence of a large forest lizard, called by the Maoris kaweau. In 1870 an Urewera chief killed one under the loose bark of a dead rata, in the Waimana valley; he described it to me as being about two feet long, and as thick as a man's wrist; colour brown, striped longitudinally with dull red.

These islets at one time abounded in hot springs; in places the shores consist entirely of silicious deposits, contorted in the most fantastic manner. Most of the rocks are, I think, trachytic.

Rurima is famous for its fish; hapuka (*Oligorus gigas*), kahawai (*Arripis salar*), snapper (*Pagrus unicolor*), tarakihi (*Chilodactylus macropterus*), moki (*Latris ciliaris*), king-fish (*Seriola lalandii*), wharehou (*Neptomenus brama*), barracoota (*Thyrsites atun*), mackerel (*Scomber australasicus*), and the delicious little maomao, can be caught in immense quantities. The koura, or sea cray-fish, is unusually large, and may be found anywhere under the sea-weed about low water-mark. Tokata, a rock looking something like a boat or canoe, and forming the in-shore limit of the group, is a great place for hapuka, while a rock, awash at half-tide, lying beyond all the rest to seaward, was in the olden time celebrated for the ngoiro, or conger-eel (*Conger vulgaris*); but the best fishing that I have ever met with was half-a-mile or thereabouts off the little sandy bay which I have described, by bringing the northern end of White Island just in sight to the left of Moutoki cone, and the inshore side of the western hummock of Rurima proper just clear of the inner face of the most southern hummock. In four or five fathoms water, with six lines, we had a whale-boat half full in an hour. The first fish hauled in were followed to the surface by swarms of snapper, kahawai, kingfish, barracoota and maomao, and then we simply bobbed for them as you would for minnows in a brook until my arms ached with the exertion of lifting them over the boat's side.

I have never seen a spot so well adapted for a fishing station. Were it utilised in this manner in all probability the trees would be felled, the birds would seek other nesting-places, the tuataras would be exterminated, the mysterious dripping well would dry up, and some of Rurima's most interesting features would disappear, but its fisheries would not be surpassed on the coasts of New Zealand.

II.—ZOOLOGY.

Art. XIX.—*On the Whales and Dolphins of the New Zealand Seas.*
By James Hector, M.D., F.R.S.

[*Read before the Wellington Philosophical Society, 6th November,* 1872.]

The study of Cetaceans is beset with difficulties not experienced in other groups of the fauna of a country. The huge size of most of the species prevents the preservation of complete specimens, and opportunities occur but rarely when they can be examined in the recent state, prior to the preservation of the skeleton.

Many of the genera and species have for this reason been founded on imperfect and fragmentary skeletons that have not been identified with the living animal, so that their descriptions are necessarily almost as vague and inconclusive as those of the fossil remains of extinct forms. The following notes refer chiefly to specimens in the Colonial Museum, and are only offered in the hope that they may assist in the collection of more accurate information than we at present possess respecting this most interesting section of our fauna.

The most complete work of reference on this subject is Dr. Gray's "Catalogue of Seals and Whales in the British Museum," 1866,* taken along with his amended synopsis published in 1868.† The classification adopted in the latter work has been chiefly followed, except with reference to the Ziphid whales, in which I adopt the groups proposed by Professor Flower in an article contributed to *Nature* in December last.

It should be remembered that in many cases, and especially in the latter group, the classification is that of the anatomist, or rather the osteologist only, while in some other cases in which the external characters of the animal have been obtained, the distinctions are sufficiently minute to satisfy the systematist. On this account there is greater difference of opinion respecting the value of generic and specific characters in this order than in almost any other, and a corresponding confusion and instability in the nomenclature. It is therefore important that no opportunity should be neglected of collecting not only specimens but also of making sketches, however rough, with exact measurements of the larger species, showing the proportions, position of fins, and other

* "Catalogue of Seals and Whales in the British Museum," by J. E. Gray, F.R.S., 1866.

† "Synopsis of the Species of Whales and Dolphins in the Collection of the British Museum," by J. E. Gray, Ph.D., F.R.S., 1868.

characters. As Cetaceans are not unfrequently cast up on the coast of New Zealand, I may state, for the guidance of collectors, that the bones which it is most important to preserve are the skull and ear bones, vertebræ of the neck, shoulder blade, first two or three ribs, and a few of the segments selected from different parts of the vertebral column, but in the smaller species the whole skeleton should be collected if possible.

NEOBALÆNA MARGINATA.

Western Australian Whale.

Balæna marginata, Gray, "Cat. Seals and Whales," p. 90; Hector, *Trans.* N.Z. Inst., II., 26, Pl. 2b. *Caperea antipodarum*, Gray (in part) l.c. 101. *Neobalæna*, Gray, "Ann. and Mag. N.H.," 1870, 154; *Trans.* N.Z. Inst., III., 123.

Ear Bone, Pl. VI., figs. 1a. and b.

This whale has been described only from some plates of baleen in the British Museum, and from the skull and baleen of a small individual, 16 feet long, that was cast ashore on the island of Kawau, and is considered by Dr. Gray to represent in the Southern Seas the great Right Whale of the Arctic Ocean.

The baleen or whalebone is the most flexible, elastic, and toughest of any yet discovered, but is of very small size. It is on account of this character, taken along with the proportional dimensions of the baleen, that Dr. Gray places this whale among the true Balænidæ, but the external characters of the animal have not yet been observed.

The young skull, which is 4 feet 9 inches long, is depressed, and may be recognized from other baleen whales by the great length of the brain cavity, which very nearly equals the beak, and by the feeble articulation of the lower jaw. The baleen is slender, white, with a black outer margin, frayed on the inner edge to a fringe of single fine hairs, and having a highly enamelled surface.

The ear bones (Pl. VI., figs. 1a. and b.) are oblong, rough, the outer margin thick and rounded, the lower edge truncate, and the back convex. The aperture is contracted above but wide below, the wide portion being less than half the length of the bone. It is evidently on the ear bone of this species that Dr. Gray has founded his *Caperea antipodarum*, or New Zealand Right Whale, a species which must therefore be reserved until supported by further observation.

EUBALÆNA AUSTRALIS.

The Black Whale—Tohora.

E. australis, Gray, l.c. 91. *Balæna (Caperea) antipodarum*, Gray, (in part) l.c. p. 101 ; Dieffenbach's N.Z., II., Tab. 1.

Ear bone, Pl. VI., f. 2.

These two species are for the present placed together because whalers do not recognize two kinds of Black Whale, and the only portion of the second species which is described by Dr. Gray is an ear bone sent to the British Museum from Otago by Mr. Stuart, but which, as already stated, I find to agree with that of his *Neobalæna marginata*. The skeleton of *Caperea antipodarum* in the Paris Museum (Gray, l.c. 371), taken on the coast of New Zealand, is however considered by Professor Flower to differ from that of *B. australis* in having square nasal bones and a simple (not forked) first rib.

The Black Whale is the largest and best known of all the whales on the New Zealand coast, reaching a length of 60 feet. Its huge bones may be seen strewn on the beach in great profusion at any of the whaling stations, but generally in a bad state of preservation. The skull is triangular, convex, with the beak bent down rather suddenly, and the posterior part depressed, the brain cavity being only one-third the length of the beak. The vertebræ of the neck are united into a compact mass, the spinous processes forming a solid crest. The ear bone (Pl. VI., fig. 2) is rhombic, with a large oblong aperture. The baleen is thick, rather brittle, with thin enamel, and margined with a thick fringe. The blades are from 2 to 9 feet in length.

The females visit the bays and inlets round the coast to calve during the winter months from May to August, where they are captured by the shore whalers. The males are seldom caught, as they rarely approach the land and are more shy and wild than the females. From October to May the Black Whales are only captured by cruisers on the whaling ground which extends from the Chatham Islands to Norfolk Island.

Several vertebræ, and two imperfect tympanic bones of this whale are in the Museum.*

MEGAPTERA NOVÆ ZEALANDIÆ.

New Zealand Humpback.

M. novæ-zealandiæ, Gray, l.c. 128.

Ear bone, Pl. VI., figs. 3a. and b.

This species is also founded by Dr. Gray on the ear bone alone, and has not been clearly identified. A whale that was captured in Wellington

* A very perfect tympanic and periotic bone has been obtained in Preservation Inlet, on the West Coast of Otago, since the above was written, and agrees with the figure of the Ear Bones of the adult *Balæna australis* given in Huxley's "Comp. Anatomy," p. 397.

Harbour in 1869 appears to have been of this species from the character of the ear bone, which unfortunately was the only part preserved of the animal, which measured 34 feet in length.

The Humpback whales are well known to whalers, but are seldom molested. According to Bennett they roam about the ocean in small herds, seldom at any great distance from land. They are to be recognized by their having a short robust form, broad flat-topped head, a low broad dorsal fin or lump behind the middle of the body, very long pectoral fins, and the skin of the throat and chest deeply plaited with longitudinal folds.

The baleen is short, broad, and triangular, but much longer than the breadth at the base, edged with bristles that are thick and ridged near the tip. (Gray.)

There are in the Museum three ear bones (Pl. VI., figs. 3a. and b.) which I refer to this species, one of them being from the skull of the individual referred to as having been caught in Wellington Harbour.

PHYSALUS AUSTRALIS.

Southern Finner, or Razorback.

P. australis, Gray, l.c. 161. *P. antarcticus*, Gray, l.c. 164.

The only reason suggested by Dr. Gray for distinguishing the second of the above species is that a quantity of Finner's baleen has been imported from New Zealand that is yellowish-white, the baleen of the Northern Finner or Great Rorqual (*Physalus antiquorum*) being slate grey, but the colour of the baleen of his *Physalus australis* is not mentioned so that the above distinction requires to be verified. The Finners are the longest of the whale species, and are distinctly referred to by some authors as occurring in the New Zealand seas. They are, however, rarely caught, as their great size and activity render them formidable antagonists, while the quantity of oil they give is small and their baleen has no commercial value. Like the Humpbacks they have the throat and belly longitudinally plaited, but differ in having a high falcate dorsal fin and pectorals of moderate length. The bones of the neck are not united.

This whale is not represented as yet in the Colonial Museum.

CATODON MACROCEPHALUS.

Sperm Whale.

C. macrocephalus, Lacép, Gray, l.c. 202.

The Spermaceti Whale is not uncommon in the north latitudes of New Zealand, eastwards to the Chatham Islands, and occasionally as far south even as Stewart Island. According to Dieffenbach, they often fall a prey to the

whaling ships which cruise in the open sea, but rarely approach the coast like the Black Whale. Several teeth of Sperm Whales are in the Museum, and also other varieties of smaller sized teeth of several forms, chiefly found on the east coast of Wellington, which have not yet been referred to any species. Dieffenbach mentions a Sperm as having been brought ashore in Tory Channel, respecting which Mr. Wilson, an old whaler now living at Waikanae, informs me he was one of the party that secured this very whale, and that it was a dead animal, in such an advanced state of decomposition that nearly all the bones had dropped out of the flesh He states that such boneless bodies of whales are not uncommonly met with drifting about in the ocean. The head of a large Sperm Whale used to lie in the sand-hills south of Waikanae, but was broken up by the natives some years ago for the sake of the teeth.

DELPHINUS FORSTERI.

Forster's Dolphin.

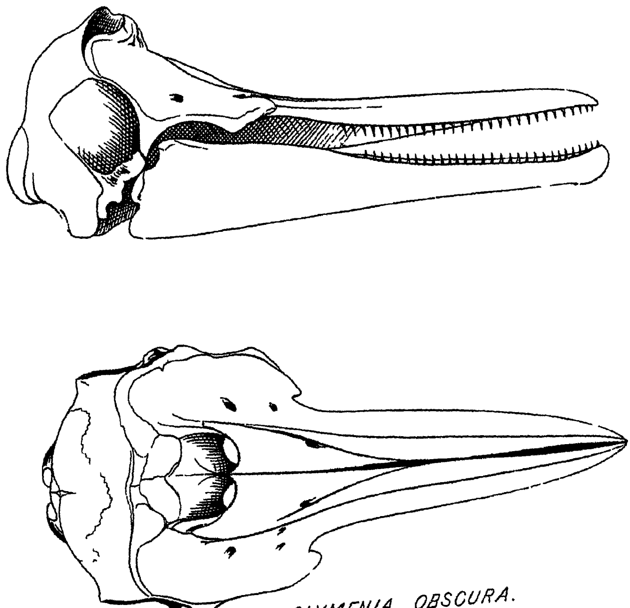
D. forsteri, Gray, l.c. 248.

Pl. II. and III.

The skull of this species, which was founded on a drawing by Forstor, has not been described, but I provisionally refer to it two skulls obtained on the west coast of this province, which do not agree with any described species, though resembling most nearly the Cape Dolphin (*D. longirostris*, Gray, l.c. 241), but differing from it in having a much shorter beak and fewer teeth.

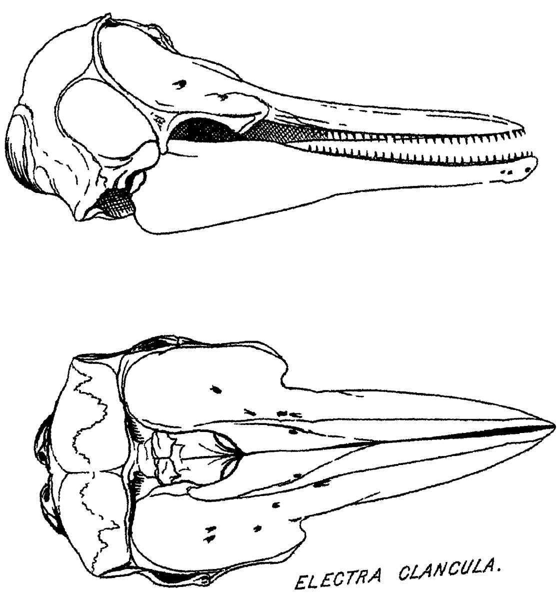
Skull rounded behind ; beak rather linear, depressed on the sides, three-fifths the total length, and three times the width at the notch ; intermaxillaries narrow, forming a prominent hard ridge, and united for a third of their length to form a bony tube ; maxillaries with a third ridge in front of the notch ; hinder wing with a flat area over the orbit, and bent up posteriorly ; supra-occipital crest prominent ; forehead sloping ; blowers small, equal to middle width of beak ; nasal processes prominent ; triangle rough, without defined margins, not extending to the teeth ; symphysis of lower jaw equal to half the width of beak at the notch ; *Palate with a groove on each side*, deep behind and shallow in front.

A.—Skull, Waikanae beach. B.—Skull, Wanganui beach, from Rev. R. Taylor, F.G.S. C.—The skull of a porpoise, captured in the South Atlantic in June, 1872, during the voyage of the "Electra" from London to New Zealand, agrees with the above in every respect, except in the teeth which are fewer in number. The teeth are quite perfect, and are small and incurved. This specimen has been taken to England by James Brogden, Esq.

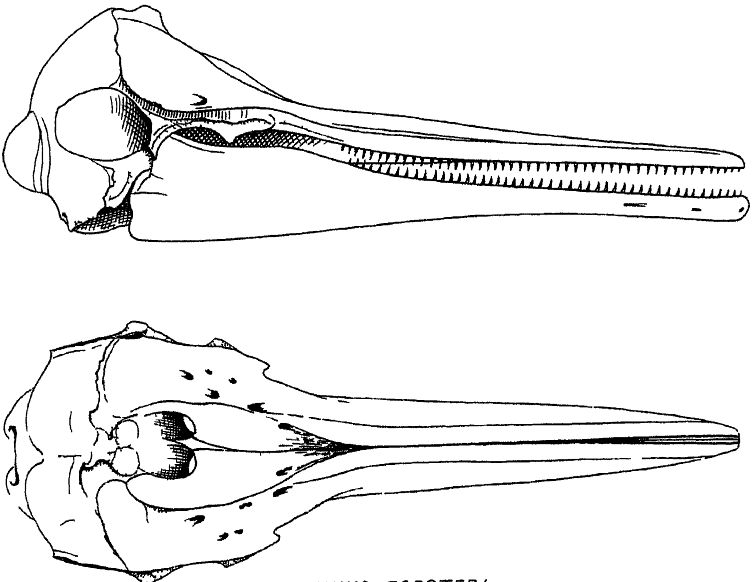


CLYMENIA OBSCURA.

1/5 Nat size

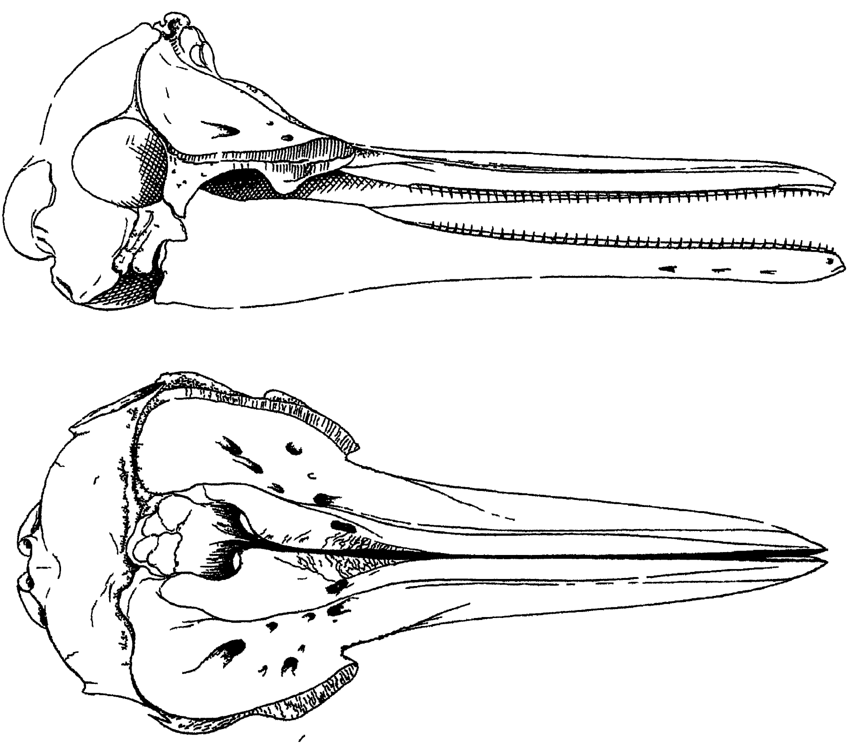


ELECTRA CLANCULA.



DELPHINUS FORSTERI

1/5 Nat size



MEASUREMENT OF SKULLS IN INCHES.

	A.	B.	C.
Total length ...	18	17	17·5
Length of beak ...	12	11	10·5
Width at notch ...	3·6	3·5	3·5
Width at middle of beak ...	2	2	2
Teeth ...	$\frac{15}{17}$	$\frac{16}{18}$	$\frac{14}{12}$

The following is abridged from Forster's description of the Porpoise, to which I attribute these skulls:—

Teeth $\frac{14}{14}$ Body straight, round, thickest behind; head rounded, shelving in front; beak, pointed, straight, attenuated; lower jaw longest; dorsal fin in middle of back, triangular falcate; tail lobes sub-falcate; tail attenuated, keeled above and below; pectoral lanceolate, scarcely as long as the beak.

Greenish brown or rust colour above, white beneath, a white spot on the dorsal and pectorals. Length, 6 feet. (Gray, l.c., 248.)

I have frequently seen a porpoise answering to this description, as far as could be judged from a boat, in Queen Charlotte Sound and Blind Bay.

CLYMENIA NOVÆ ZEALANDIÆ.

Cow-fish.

Delphinus novæ-zealandiæ, Q. and G. Gray, l.c. 246.

Pl. II.

The skull of a large porpoise cast ashore at Waikanae appears to belong to this species, but having a flat palate it must be removed from the genus *Delphinus* to *Clymenia*. It resembles *C. euphrosyne*, but has a more slender beak and a larger number of teeth in the lower jaw.

Skull rounded behind, forehead sloping rather abruptly; crests and nasal bones prominent and rough; maxillaries spongy, expanded, posterior wing with horizontal and ascending areas; intermaxillaries elevated, callous, a little expanded in the middle of the beak, not united, and wide apart in front.

Triangle bounded by a callous ridge, very rough, extends beyond the hinder teeth; blower small, equal to half the width at notch; *palate flat*; length of symphysis of lower jaw equals one-third the width at the notch.

Length	19 inches.
Beak	11·5 „
Width at notch	4·5 „
Width in middle	3 „
Teeth	$\frac{44}{47}$

The description of *D. novæ-zealandiæ*, to which I suppose the skull to belong, is as follows, and applies with deviations in colouring to a very large species of porpoise that frequents the West Coast Sounds and is known as the Cow-fish :—

Teeth $\frac{48}{47}$; body elongate, rounded in front; beak cylindrical, flattened, and pointed; lower jaw longest; forehead rounded and prominent; dorsal fin large, triangular, rounded at tip; tail-lobes flattened, with a compressed keel between the base and the dorsal fin; caudal small, nicked, cordate; pectorals moderate, falciform.

Above black-brown, edge of upper jaw and beneath dull white, with a yellow band from the edge along the side to beneath the dorsal; tail slate colour; pectoral and dorsal dull white, the latter with a dark edge. The lower jaw with small pores, and the body with small plates of regularly twisted white striæ.

Length 5 feet 10 inches, (Gray, l.c., 246.); but the Cow-fish reaches to at least 8 feet in length.

CLYMENIA OBSCURA.

Tursio obscurus, Gray, l.c. 264.

Pl. I.

Skull much rounded behind; crests feeble but sharp; forehead slightly concave in outline; maxillaries sloping on side of beak, constricted and rough before the notch, and with a slightly concave hinder wing; intermaxillaries not elevated, tapering, callous, with a marked ridge bounding the triangle which extends to opposite the twelfth tooth from the back; blowers very wide, equal to two-thirds the width at the notch; symphysis of lower jaw short, equals one-fourth of jaw; *palate flat*; teeth $\frac{34}{28}$.

This skull, obtained on the Wanganui beach by the Rev. R. Taylor, agrees with the figure and description of the above species.

The body is described as black, with diverging streaks on the side, and whitish beneath. It has a distinct dorsal fin situated two-fifths from the snout; the entire length being about 5 feet.

ELECTRA CLANCULA.

New Zealand Bottle-nose.

Lagenorhyncus clanculus, Gray, l.c. 271. Hector, "Ann. and Mag. N. H.," 1872, 436.

Pl. I. and III.

Teeth $\frac{32}{32}$; head convex; snout conical; lower jaw longest; body fusiform; greatest height one-fifth total length; pectoral narrow, falcate, equal in length

to base of dorsal; a single dorsal, low and rounded, commences at middle of back and over the umbilicus. Tail-lobes narrow, falcate, each one-third longer than the pectoral.

Nose and forehead pure white, bounded by a crescent of black behind the blow-hole, sharply defined in front, but shading off behind to light grey, which is the uniform colour of the upper surface of the body. Fins are all darker than the trunk; there is also pure black round the blow-hole, cloaca, and vent. The white of the snout extends behind the eye, but the dusky colour extends forward beneath the angle of the mouth. The lower aspect is white as far back as the vent, but is crossed by an isthmus of dark grey beneath the pectorals. The white band is continued by two lateral stripes that ascend on the flanks. The colouring, as far as I have been able to judge by casual inspection is very uniform in all the individuals.

This dolphin differs in external characters from the genus *Lagenorhynchus* (as described in the "Catalogue of Seals and Whales," p. 267) in the forward position of the dorsal, and the absence of a second fin-lobe on the back.

Common in Cook Strait, and on the West Coast as far south as Jackson Bay, travelling in large schools.

A Bottle-nose shot in 1871 had a total length of 51 inches, girth 32 inches, and weight 78 lbs.

DIMENSIONS.

		Inches.
Snout to anterior margin of pectoral	... ...	12
,,	angle of mouth	6
,,	blow-hole	8
,,	commencement of dorsal	24
,,	umbilicus	24
,,	vent	36
Length of base of dorsal	... ...	8
Spread of tail	... ...	15
Length of anterior margin of tail-lobe	... ...	12

There is a complete skeleton and several skulls and lower jaws in the Colonial Museum, this being the most commonly cast up of any of the dolphins round the coast.

The skull is flask-shaped, the beak being wide at the base, rapidly tapering to an acute point in front, with the edges bevelled in a regular manner. The teeth are small, cylindrical, curved, and pointed. *Palate slightly concave.*

The length of the adult skull is 11 inches, the beak forming half the length, and being three times the width of its middle part; height of the occiput 5·7 inches. The cervical vertebræ are anchylosed into a solid mass 1·3 inch in length.

The dentition of the various specimens in the Museum is as follows, and shows that this character is a reliable one for the determination of species.

	Length of lower jaw.	Teeth.
1. Skull of complete skeleton	11·	$\frac{32}{31} - \frac{31}{31}$
2. " " "	9·	$\frac{31}{31} - \frac{31}{31}$
3. Skull	10·	$\frac{32}{31} - \frac{31}{31}$
4. Lower jaw	12·5	$\overline{31} - \overline{32}$
5. " "	12·	$\overline{31} - \overline{31}$
6. " "	12·	$\overline{31} - \overline{31}$
7. " "	11·	$\overline{31} - \overline{32}$

In every case three or four of the front teeth are feeble and irregularly developed, the variation in the numbers observed depending on the condition of this part of the jaw.

The other teeth are cylindrical and acutely incurved, the middle ones being the best developed.

TURSIO METIS.

T. metis, Gray, l.c. 256.

Animal unknown. Skull globular; back of blower tubercular; rostrum thick, conical, tapering, longer than head, and more than twice as long as width at notch; intermaxillaries convex and more than half the width of the beak; triangle extends to the commencement of the tooth series; *teeth large*, the sockets being half an inch from centre to centre, $\frac{22}{21} - \frac{22}{21}$.

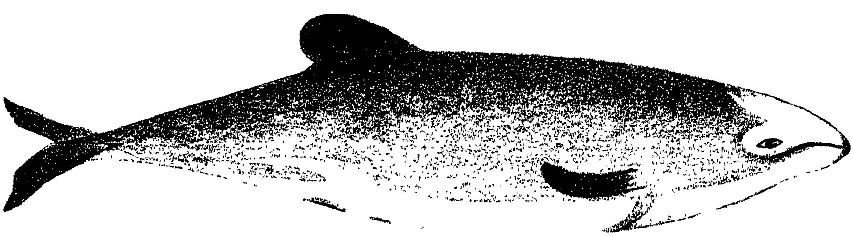
To this species, which is founded on a single skull in the British Museum, the habitat of which is unknown, I refer a skull obtained by Mr. T. H. Potts at Dusky Bay, which has the following measurements :—

	Inches.
Length	21·
Width at orbits	10·
" notch	5·3
" middle of beak	3·
Length of beak	11·5
" lower jaw	17·5
" dental groove	10·

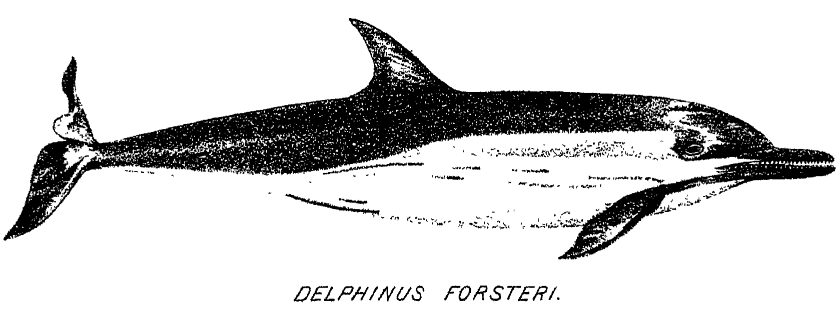
The teeth are wanting, but the lower jaw appears to have had a slightly larger terminal tooth on each side directed obliquely forwards. The tooth sockets are very large, and nearly an inch in depth. The lower jaw is very stout.

J B. del. et lith.

DOLICHODON LAYARDII.



ELECTRA CLANCULA.



DELPHINUS FORSTERI.

PSEUDORCA MERIDIONALIS.

Tasmanian Black Fish.

P. meridionalis (Flower), Gray, l.c. 291.

Teeth, $\frac{8}{10}\frac{8}{10}$; head rounded, scarcely beaked; black on back and sides, lighter below; male head larger than female; head obtuse, like that of a Sperm Whale; pectorals small; dorsal hook-shaped, situated one-third the total length from the tail; teeth conical, acute, very large; compressed on the sides; skull rounded; beak short, tapering; intermaxillary broad. (Gray.)

An imperfect skull in the Colonial Museum appears to resemble this species. The occipital area is rounded and tumid without any marked crests or ridges. Its length is 9 inches, and the width at the notch is 13 inches. The whole of the beak is wanting. The bones of this skull have a soft porous texture. It was picked up in Lyall Bay.

To this species I also refer the skeleton of a young animal found on the Kaiapoi beach, and now being prepared for the Canterbury Museum. The teeth $\frac{10}{10}-\frac{10}{10}$ are rather widely set, black in colour, incurved, and many of them split longitudinally.

GRAMPUS RICHARDSONI.

G. richardsoni, Gray l.c. 299.

Teeth $\frac{}{4}-\frac{}{4}$; lower jaw straight, regularly diverging, scarcely bulging on the side behind, united with a rather long, wide symphysis, obliquely truncate in front, with a rather prominent tuberous gonyx; teeth far apart, conical, tapering at tip, but sub-cylindrical at base.

Animal unknown. Cape seas.

A lower jaw obtained on the Manawatu beach, and placed in the Museum by Dr. Buller, appears to agree with the above, but has only three teeth on each side.

Its length is 15 inches.

BELUGA KINGII.

B. kingii, Gray, l.c. 309.

Teeth $\frac{10}{9}$; head rounded; teeth conical, hooked, often truncate, the upper ones often wanting; no dorsal; skull with nose and outer wing of maxilla bent over the orbits, making the forehead very convex; beak short, not half the length of the skull, and scarcely longer than the width at the notch; skull, entire length 13·5 inches; beak 5·5 inches; width at orbits 8 inches, at notch 4·5 inches. (Australia.)

A very imperfect skull in the Museum from the Swainson collection agrees with the above dimensions and characters as far as can be ascertained. A large light-coloured porpoise is not uncommon at certain seasons in Blind Bay, which may perhaps be this species.

GLOBIOCEPHALUS MACRORHYNCHUS.

New Zealand Black-fish.

G. macrorhynchus, Gray, l.c. 320.

Teeth $\frac{8}{8}-\frac{8}{8}$; head very much swollen, thick, square, and short; snout blunt; teeth, sub-cylindrical; angles of the lip curved upwards; body clumsy and terminates abruptly; colour uniform black; skull broad; beak wide, nearly as broad at the middle as at the notch; intermaxillaries expanded to cover nearly the whole upper surface.

Total length 16 to 20 feet. (Gray.)

Two skulls in the Colonial Museum, prepared by Dr. F. Knox; length 26 inches; height of occiput 14 inches; length of beak 15 inches, and width at notch 11 inches.

Five cervical vertebræ anchylosed.

The Black-fish visit the coast in large schools, and occasionally run into shallow bays, where they get stranded, and fall a prey to the natives and settlers. They yield from 30 to 35 gallons of inferior oil, but are not killed without some risk, as they occasion a sickness or vertigo to those who slaughter them, which has sometimes been attended with fatal results. (See *Trans. N.Z. Inst.*, I., 44.)

EPIODON CHATHAMIENSIS.

Goosebeak Whale.

Pl. IV. and V.

Beak of skull tapering with a slight upward curve; vomer forming a callous ridge, depressed between the intermaxillaries; upper jaw toothless, lower jaw elongate, tapering, bent up and truncate, terminating in two short cylindrical teeth, with a sunken dented groove behind them.

A skull, without styloid processes or tympanic bones, and having the sperm cavity laid open, collected by Mr. H. Travers at the Chatham Islands, has the following dimensions:—

	Inches.
Total length, with lower jaw	36
Width at orbits	20
Width at notch	12
Height of crest, above occipital foramen	15

						Inches.
Width of occiput	...	.	.	..	...	15
Length of beak from pre-orbital notch			...	. .	...	18
Brain cavity—length ...		. .	. .	...	...	6
Sperm cavity—length ...		...	...	...	...	12
" ". width ..		...	...	...	...	5
Width of beak at 12 inches from extremity				...	...	5
Lower jaw—length ...		...	...	...	...	30
" " height of ramus			...	...	...	7

Weight of teeth 817 and 836 grs.

The beak is trigonal, obliquely truncate, and slightly upturned, three times the length of the brain cavity; vomer is small, fusiform, truncate posteriorly (probably from its having been broken off in opening the sperm cavity) callous and depressed in a groove that is formed by the thin callous margin of the intermaxillaries, which are continued backwards to form a moderately high ridge, inclosing an oval basin, and rising to a deeply-notched crest that overhangs the blowers at the level of the supra-occipital crest; the beak is slightly unsymmetrical at the point, being twisted to the right; the blowers are strongly twisted to the left; the maxillaries are slightly elevated, inclosing a lateral groove on each side of the beak, which groove expands backwards to form shallow supra-orbital basins.

On the lower aspect of the beak there are imperfect dental grooves, but no tooth sockets, nor any acute tubercular granulations as described in *E. desmarestii.*

The lower jaw projects three inches beyond the beak, the thin callous rami having straight, entire, upper margins as far as the commencement of the symphysis, where they curve upwards and end in a conical, truncate point, which is level with the upper surface of the beak when the mouth is closed, and terminates in two short, stout, slightly compressed teeth (Pl. V., 2a. and b.), two inches long and four in circumference, implanted in shallow sockets. The teeth have slight irregular striæ, and are worn down into two lateral facets divided by an acute ridge. The position of the teeth, when the jaws are closed, is two inches beyond the upper mandible, and unless they are applied against callosities on the upper lip it is difficult to conceive how they are worn down to this acute form. Two teeth of similar form, taken from the jaw of a whale cast up on the Manawatu beach, have their facets forming an obtuse pyramidal tip (Pl. V. 3.) A shallow dental groove extends back from the tooth sockets for fifteen inches with well marked nutrient foramina that indicate twenty-two suppressed teeth.

Only two species of *Epiodon* are known, and it is possible that the above may be identical with *Epiodon australis* from Buenos Ayres, the description of

which I have not seen. Except in the upward curve of the beak, and the less development of the vomerine callosity, this skull resembles *Petrorhynchus capensis*, Gray, l.c. 345*.

Since the above was written I have examined the skull of a very old female specimen of this whale, captured in Port Cooper, the complete skeleton of which is being prepared in the Canterbury Museum; it has the same measurements and general form with the Chatham Islands specimen, but the sperm cavity in front of the blow-hole is covered in by a thin callous plate. The teeth at the extremity of the lower jaw were nearly absorbed, being reduced to conical fangs, with rough surfaces, having constricted sub-cylindrical summits terminating in short acicular tips, and were so deeply imbedded in the gums that their presence was overlooked until after maceration.

Dr. Haast informs me that the length of this whale was 28 feet, and that it had no dorsal lobe. The colour was black above and white beneath, but the back and sides were marked with oval spots 2 to 3 inches across, like the skin of a leopard.

The rostrum of an individual of this species, found at Lyall Bay, near Wellington, having a less upward curve, is in the Colonial Museum.

DOLICHODON LAYARDII.

Scamperdown Whale.

D. layardii, Gray, l.c. 353. *Mesoplodon*, Flower, l.c.

Pl. III.

Teeth 2, on sides of lower jaw, strap-shaped, produced, arched, obliquely truncate at the end, with a conical process on the front of the terminal edge.

Lower jaw, Chatham Islands, obtained by Mr. H. Travers.

The total length of this jaw is 2 feet 9 inches; the posterior third is thin, convex externally, expanded, having a height of 6 inches. It is then straight, and compressed in its middle third as far as the commencement of the symphysis, which unites the *rami* for their anterior third into a straight

* The following is the manner in which the Ziphid Whales should be grouped according to the views expressed by Professor Flower in a recent paper—"Nature," Vol. V., No. 110, p. 105, Dec. 7th, 1871:—

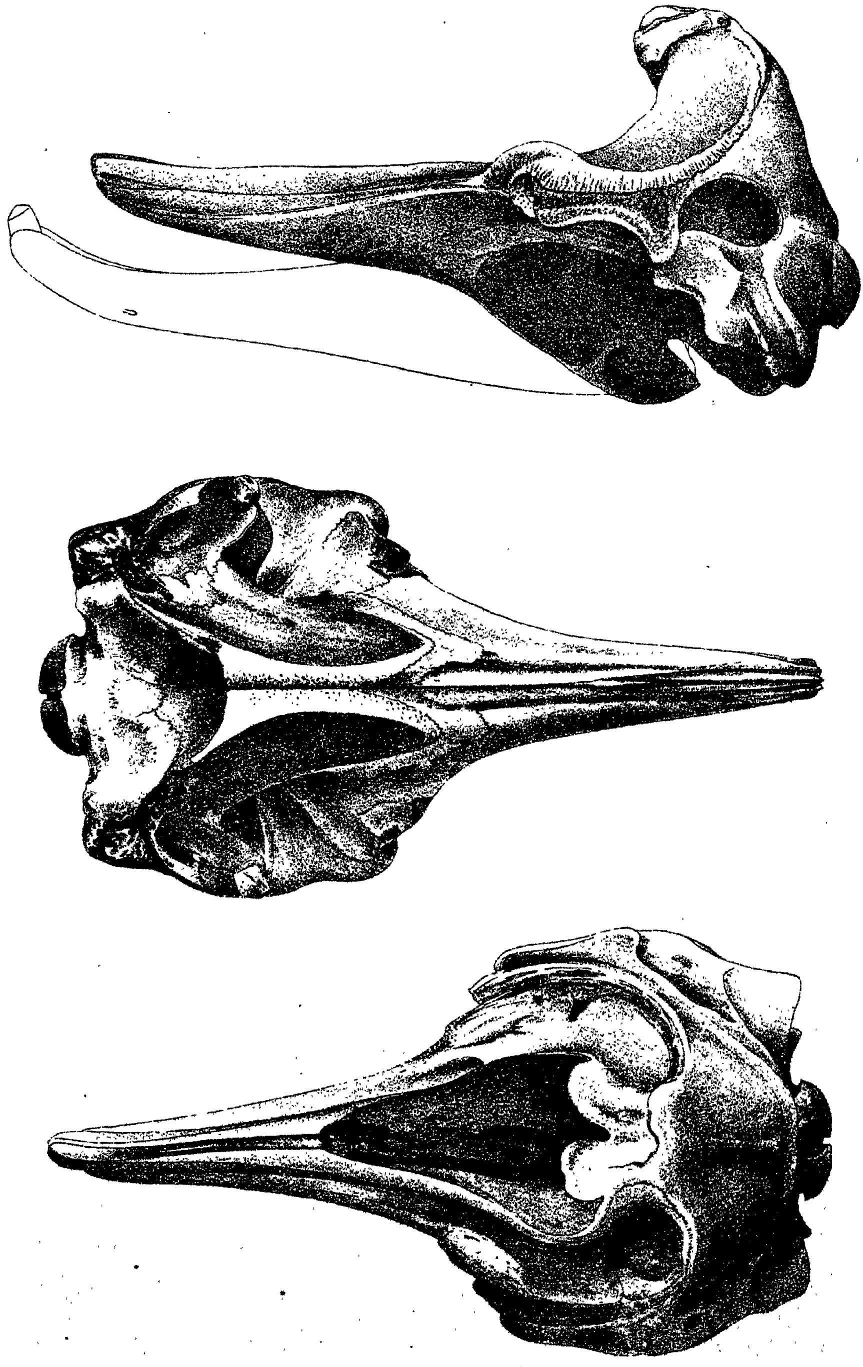
ZIPHID WHALES.

I. Genus *Hyperoodon*, Lacépède.
- H. rostratus, Wesmael.
- H. latifrons, Gray.

II. Genus *Ziphius*, Cuvier.
- Z. cavirostris, Cuvier.
- Z. indicus, Van Beneden.
- Z. (Petrorhynchus) capensis, Gray.
- Z. (Epiodon) australis, Bur.
- Z. (Epiodon) chathamiensis.

III. Genus *Mesoplodon*, Gervais.
- M. (Ziphius) sowerbiensis, Gervais.
- M. (Z.) layardii, Gray.
- M. densirostris, De Blainville.
- M. knoxi.

IV. Genus *Berardius*, Duvernoy.
- B. arnuxii, Duv.



J.B. del. et lith

EPIODON CHATHAMIENSIS
1/8 nat size


2 a
1 a

conical beak, channelled above and rounded below. The hinder edge of the tooth is 18 inches from the condyle, the width of the base of the tooth is 5 inches, and its anterior margin is $1\frac{1}{2}$ inches in advance of the commencement of the symphysis. The lower margin of the jaw is swollen opposite the insertion of the teeth, which are deeply inserted, and slope obliquely backwards, with a decided incurvature towards the mesial line. The teeth are 6 inches long, 3 inches wide, and $\frac{3}{4}$ inch thick. The acute point on the upper angle is very marked, and the anterior edge is worn into a deep notch, with a rough surface showing the laminated structure of the tooth. It is implanted in the jaw by seven or eight fang-like processes, as if formed by the fusion together of a number of teeth.

There is no socket or notch in the jaw posterior to the tooth, the upper edge of the jaw being sharply defined, but from the tooth forwards there is a distinct dental groove showing the remains of alveolar processes.

The species to which I refer the jaw is only known from a single specimen obtained at the Cape of Good Hope, which differs in the greater height and more marked incurvature of the teeth. As it is a larger individual, the lower jaw measuring 3 feet, this difference may be due to age or sex.

MESOPLODON KNOXI.

Mesoplodon, Flower, l.c. *Berardius arnuxii* (Duv.), Hector, *Trans.* N.Z. Inst., II., 27. Smaller Ziphid Whale, Hector and Knox, *Trans.* N.Z. Inst., III., 125. Pl. XIII., XIV. and XV.

Ear bones; Pl. VI., 4a. and b.

Teeth $\frac{}{2}$; body fusiform; head rounded, beaked, upper snout long and flexible; eye half way between the angles of the mouth and the pectorals, which are small; dorsal over the tail; tail-lobes large, falcate (Knox); skull globular, with a slender conical beak; intermaxillaries form thin linear callous plates, incurved, and inclosing a deep groove occupied by a ligament that extends back from the snout to the blow-holes (as in *Berardius*), where the groove is closed by the slightly expanded front edge of the septum. [In the adult this groove is obliterated, and the upper surface of the beak forms a hard callous ridge, as in *Epiodon.*] They then form a flat lunate area in front of the blow-holes, and behind rise vertically to form moderate knob-like

* Dr. Gray informed me in January last that he intended to describe this species under a different name, but not having heard from him again on the subject I adopt the name I originally suggested in compliment to Dr. F. Knox, the veteran anatomist, who has devoted much of his leisure to the study of Cetaceans during thirty years residence in this Colony.

crests, separated by a notch, the nasal bones being feebly developed; the maxillaries commence at the sides at some distance from the tip of the beak, but expand behind into a slightly concave surface that covers the whole of the frontal area; the supra-occipital is convex; blow-holes are straight, almost equally developed, and vertical; the skull being only very slightly unsymmetrical; lower jaw expanded and convex behind, produced and slender in front, united by a symphysis equal to one-third the total length of the bone, and which is slightly ascending; the teeth are deeply implanted in the top of the jaw, and were completely inclosed in the gums, so as only to be discovered by dissection; they are small, quite compressed, of oblique triangular shape, rough at the base, but with a sharp polished tip. Their weight is about forty grains each.

A. Skull (for dimensions, see *Trans.* N.Z. Inst., II., 27), cervical vertebræ, scapulæ, hyoid and pectoral bones of a specimen cast ashore in Taitai Bay near Porirua. Total length, 9 feet 3 inches. Collected by Dr. Knox. This skull was at first taken for a young *Berardius* on account of the deep groove along the beak.

Two teeth of the same shape have been obtained, the one in New Zealand, the other in the Chatham Islands, which are of much larger size, weighing over 200 grains. This circumstance, and the very spongy character of the bones, and the imperfect ossification of the sutures, lead to the belief that the above described specimen was only a young individual, and that this whale reaches a much larger size. A second skull, with part of the beak broken off, has since been found in a sandy deposit, some distance from the sea, near Wanganui. It agrees exactly in size and form with the foregoing.

B. The skull of an adult in the Canterbury Museum, picked up on the Kaiapoi beach, has the same general form, but is one-fourth larger, and is slightly different in its proportion, the beak being more slender at the notch. The groove along the upper surface of the beak is completely obliterated, and converted into a dense callous ridge, with a depressed channel on each side. The sutures of the skull have also been completely ossified, and the bone has lost the spongy texture that characterizes the two first specimens described.

The following are the measurements of the skull in the Canterbury Museum:—

	Inches.
Total length	31
Length of beak	18
Width at orbits	11
Height of occiput	10·5
Width of blow-hole	2·

Skull symmetrical. Lower jaw wanting.

BERARDIUS ARNUXII.

Porpoise Whale.

B. arnuxii (Duv.) Gray, l.c. 348, Haast, *Trans.* N.Z. Inst., II., 190. Knox and Hector, *Trans.* N.Z. Inst. III., 128, Pl. XVI. and XVII.

Ear bones; Pl. VI., 5a. and b.

Teeth $\frac{}{2}$; dorsal fin large, extended far back with a large boss in front of it; beak of skull sub-cylindrical, slender; intermaxillaries linear, slender, rather swollen on the sides of the blowers, but not reflected to form a crest; nasal bones swollen, as in *Globiocephalus*; maxillary bones, shorter externally than the intermaxillaries, flat and expanded over the orbits; teeth triangular, sub-compressed, with base rugulose; point acute and smooth in the side of lower jaw close to tip, but not protruded through the gum; pectoral fins triangular; colour deep velvety black, lighter beneath; atlas, second, third, and fourth cervicals anchylosed; fifth and sixth free.

Skull, cervical vertebræ, hyoid, clavicle and sternebræ, of a specimen killed in Wellington harbour; prepared by Dr. Knox.

Length 27 feet.

DESCRIPTION OF PLATES.

Plate I.—*Clymenia obscura*, Gray.

Side and upper view of skull, one-fifth nat. size.

Electra clancula, Gray.

Side and upper view of skull, one-fifth nat. size.

Plate II.—*Delphinus forsteri*, Gray.

Side and upper view of skull, one-fifth nat. size.

Clymenia novæ-zealandiæ, Forster.

Side and upper view of skull, one-fifth nat. size.

Plate III.—*Dolichodon layardii*, Gray. One-eighth nat. size.

1. Lower jaw, from above. 4. Right tooth, side view.
2. „ „ side view. 5. „ „ from above.
3. „ „ front view.

Electra clancula, Gray.

Delphinus forsteri, Gray.

(Reduced from Pl. XXIV., "Voy. of Ereb. and Terr.")

Plate IV.—*Epiodon chathamiensis.*

Side, lower, and upper views, one-eighth nat. size.

Plate V.—*Epiodon chathamiensis.*

1a. Side view of lower jaw. 1b. Upper view of lower jaw.

One-eighth nat. size.

W

Plate V.—*Epiodon chathamiensis.*—continued.

2a. and b. Tooth of the specimen collected by H. Travers.

3a. and b. Tooth collected by Dr. Buller (nat. size.)

Plate VI.—Tympanic Bones. Half nat. size.

1a. and b. *Neobalœna marginata*, Gray.

2. *Eubalœna australis*, Gray.

3a. and b. *Megaptera novœ-zealandiœ*, Gray.

4a. and b. *Mesoplodon knoxi.*

5a. and b. *Berardius arnuxii*, Gray.

[NOTE.—7th February, 1873—A communication just received from Dr. Gray since the previous pages were pressed enables me to add the following.—

Macleyius australiensis.

M. australiensis, Gray, "Cat Seals and Whales," 105.

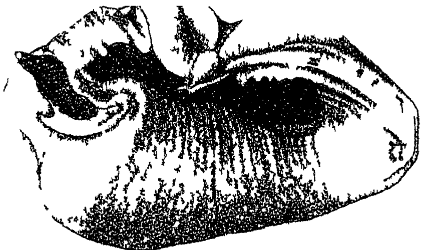
This is a new whalebone whale to New Zealand, the species having been founded on a few bones in the Australian Museum at Sydney. It has now been added to our fauna through a skeleton having been sent to the British Museum by Dr. Haast.

The minute description of the cervical vertebræ of the British Museum skeleton, given by Dr. Gray, leaves no doubt that it is the common Black Whale of New Zealand, which I have referred to above as *Eubalœna australis.*

Berardius hectori.

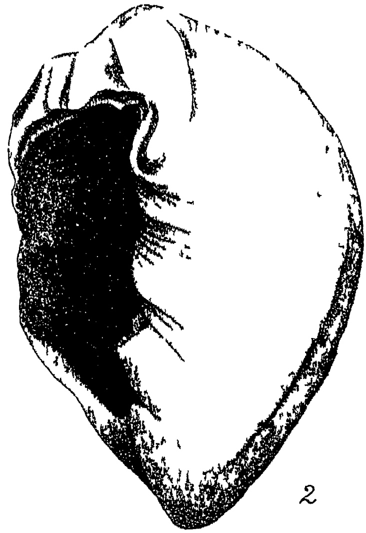
B. hectori, Gray, "Ann. and Mag. N.H.," 1871, VIII., 117.

This is *Mesoplodon knoxi* of the foregoing list. Dr. Gray mentions the skull of an allied form in the Sydney Museum as being *Mesoplodon longirostris*, Krefft. I have already mentioned that the first described skull in the Colonial Museum with the deep groove between the thin linear intermaxillaries, occupied by a ligament, is probably only the young condition of the skull in the Canterbury Museum which has a solid beak, and it is not improbable that the young animal may possess a prehensile upper lip to assist it in sucking, and that in the adult state this condition disappears, and the snout acquires the acute form.—J. H.]



1 a

1 b



2

5 a

5 b

3 a

3 b

4 a

4 b

J B del et lith

Art. XX.—*On the Birds of New Zealand.* By T. H. Potts. F.L.S.

(Part III.)

(With Illustrations.)

[*Read before the Wellington Philosophical Society, 23rd October,* 1872; *and before the Philosophical Institute of Canterbury, 4th September and 12th December,* 1872.]

List of Birds described in this Paper.

[The species are numbered in conformity with the lists given in Parts I. and II. in *Trans.* N.Z. Inst., Vol. II., Art. viii., and Vol. III., Art. xi.]

No.

6. Athene (Strix) parvissima, *Potts.*
7. Halcyon vagans, *Gray.*
12. Anthornis melanocephala, *Gray.*
16. Zenicus longipes, *Gml.*
19. Orthonyx.
20. Sphenœacus punctatus, *Quoy.*

B. 24. Gerygone sylvestris, n. s.

26. Certhiparus novæ-zealandiæ, *Gml.*
35. Zosterops lateralis, *Lath.*
36. Keropia crassirostris, *Gray.*

37–8. Rhipidura.

45. Creadion carunculatus, *Gml.*
50. Platycercus.
60. Coturnix novæ-zealandiæ, *Quoy.*
61. Apteryx australis, *Shaw.*
62. „ oweni, *Gould.*
63. „ mantelli, *Bartl.*
64. „ haastii, *Potts.*

A. 65. Charadrius obscurus, *Gml.*

65. „ bicinctus, *Jard.*

B. 65. Anarhynchus frontalis, *Quoy.*

D. 73. Ardea alba, *Linn.*

C. 78. Himantopus spicatus, *Potts,* n. s.

A. 79. Limnocinclus australis.

84. Rallus pictus, *Potts.*
87. Ocydromus.
92. Casarca variegata, *Gml.*
95. Spatula variegata, *Gould.*

A. 106. Puffinus tristis, *Forst.*

A. 119. Prion australis, n. s.

B. 131. Sterna nereis, *Gould.*

138. Phalacrocorax punctatus, *Sparrm.*

No. 6.—Athene (Strix) parvissima, *Potts.*

Dr. Finsch expresses an opinion that this small raptorial should no longer remain on the list of our fauna, but since the third volume of the *Transactions* was published, the writer has been able to collect additional evidence as to the existence of this arboreal owl.

On reference to that volume (pp. 68 and 69) it may be seen that three localities were named, in the forests and bushes that hem in the Rangitata and its tributaries, in which it had been observed.

It has also been taken at the Waimate, where it remained for a day in the roof of a hut. Mr. M. Studholme had it in his hands, but permitted it to escape. At the Waimate stands, or stood, the finest totara forest (*Podocarpus*) in Canterbury. On a visit to the Waio river, in Westland, the writer found that it had been twice observed there. In the first instance the captor, delighted with the gentle manner of the little owl, gave it liberty. The second specimen was shot at dusk, on the meat-gallows of a secluded out-station, about ten miles inland from the sea; this spot is surrounded by dense forests, which bound the river on either hand. The person who got this bird, did not think of preserving it. He described it as being of a similar brown colour above, to the more-pork (*Athene novæ-zealandiæ*), but that the feathers of the breast were marked with yellowish, that is spotted with a lighter shade of fulvous.

Mr. Phillips of Rockwood, in this province, one moonlight night captured a specimen by taking it quietly off a bough of an apple tree; here is a good instance in which no mistake could occur, as the young of *Athene novæ-zealandiæ* have been several times snared in the bush at Rockwood. Mr. Phillips, like Mr. Studholme with his bird, carried it between his hands and allowed it liberty; he described it as being about the size of our kingfisher. Note that each observer of this pretty owl was impressed with its gentleness and its fearless confidence. Both have long colonial experience, are accustomed to birds, and are men of position, well known beyond their own districts. *Athene parvissima* must not be given up, even to satisfy the most erudite of ornithologists; for how long was the shrike (*Collurincincla*) considered a doubtful species? The fiat of the ornithologist went forth, ordering our lists to be purged of *Graculus carunculatus*; yet, after a very long dive, that ornamental shag has once more come up to the surface, and "saved the number of his mess."

No. 7.—Halcyon vagans, *Gray.*

Kotare.

Kingfisher.

This valuable insectivorous bird, never molested here, remains with us throughout the year, and in greater numbers than formerly; constant familiarity

has enabled us to acquire further knowledge of the ways of the halcyon. Rather late in August, when the brown-skinned konini begins to deck its bare sprays with pendulous flowers, when the head of the straight-stemmed kowhai is already crowned with racemes of golden blossoms, *integratio amoris*, or rather the beginning of courtship, seems to occupy a share of the time which is not required to obtain the means of satisfying the cravings of the halcyon's somewhat exacting appetite. Observation has rather led us to the belief that the female takes the initiative in these amorous advances. Whilst watching several birds which were busily engaged in snatching up and bearing off *crustaceæ* from the sea-beach, in which employment the cock birds displayed most activity, usually getting three or four crabs to one picked up by a hen bird, a hen would perch herself close to a male after one of his successful darts; all unmoved, he rapped his prey on his rocky stand and proceeded to gulp it down, apparently unconscious of the blandishments of the would-be charmer. Through the month of September we have noticed similar instances of insensibility or coyness on the part of the males, under circumstances when the females have had little chance of being favoured with some choice prey as a *gage d'amour*. Forwardness on the part of "the sex" is not without precedent; we have noticed that the nuptial plumage of the female spotted shag (*P. punctatus*) reaches its full development before that of the male; frequently one may observe the red plume-like stigmas of the hazel on the spray where the male catkins hang immature.

During last season we knew of several nests that contained altogether nearly forty eggs. At each breeding place that had been excavated in a bank or wall, the tunnel *invariably* inclined upwards, the entrance at some distance from the ground, four or five feet and upwards. In one instance the hole was not more than two feet from the base of a wall built on rather a steep slope, this is noted to show that the habits of our bird differ from those of its European congener *Alcedo ispida.* In Wood's "Homes without Hands," p. 519, is a representation of the nest of the English bird, and it may be noticed there that the floor of the tunnel is nearly on a level with the surface of the water; our bird always *ascends* in entering, and *descends* on quitting the nest.

NOTE.—October 10th, first egg laid in a nest on our cliff; second egg laid on the 12th before 10 a.m.; third egg laid on the 14th; fourth egg on the 15th; fifth egg on the 16th; sixth, and last egg, on the 17th.

Subsequently the nesting place was measured, and gave the following dimensions:—Entrance rather over 2 inches in diameter, tunnel 16 inches in length; egg chamber, of ovoid form, 7 inches in length, $5\frac{1}{2}$ inches in width, with a height from the bottom of 4 inches. The size of the nest may create surprise when one thinks of the space occupied by the eggs, but a roomy home is necessary, for, like those of most troglodytal breeders, the young remain in

their hole till their wings are well grown. This stay-at-home habit saves the parents much expenditure of force, depending, as they do, for food on living prey; nor is the safety of their offspring so often jeopardised. Rapid digestion would cause the young to utter constant cries for food, which would disclose to enemies the whereabouts of each member of a scattered brood; the labour of hunting after stray young ones would be very great compared to the task of carrying food to one common feeding place. It should be noted that the egg chamber is hollowed out slightly below the floor of the tunnel, a ridge is thus formed by which the eggs and newly hatched young are kept safe from accident; in fact there is no need of a nest during incubation, the warmth that is communicated to the hole by the body of the sitting bird being very considerable.

The birds that built near us last season gave plenty of opportunity to watch their labours; steady hard work it is, indeed, that in some instances endures for weeks. After the site is selected, and a commencement made, the birds do not both leave the spot, watch being kept by one whilst its mate works or is absent after food. Should an alarm be given it is speedily answered, though from the distance of half-a-mile. Both take about an equal share of labour. On timing them it was found that if the hen worked hardest one day on the next the cock was most laborious.

NOTE.—October 23rd, hen at work in the hole three minutes, cock then took his turn; the time in the tunnel for either bird varying from a few seconds to about three minutes. When the hen flew off to feed, the cock remained to watch just below the hole; after his mate returned, in about 20 minutes, he at once recommenced work. They darted upwards from their perches into the hole, always correctly judging the distance, at the moment of entering uttering a short cry of two notes like "chi-rit." They turned when in the tunnel, as they always emerged head first. Once the hen darted to the hole and flew back, perhaps from timidity, more likely from coquetry, then sought the cock, who bent down from his perch and caressed her with his bill. Early in the morning, from five to six o'clock, little work was done, that part of the day seeming to be the time allotted for feeding, but the state of the tide might have had something to do with this as the greater part of their food is procured from the mud-flats at ebb tide.

A notable instance of their perseverance was given this season; a pair fixed for the site of their nesting place the back of a plaistered sod chimney attached to an empty cottage; they were working at the chimney on the 19th of October. After commencing on the egg chamber this nest was abandoned, probably the wall not affording what was considered by them a sufficient depth for the safety of their offspring.

NOTE.—November 3rd, they were hard at work with a fresh nest in front

of the cottage, between the door and a window; this was deserted for probably the same reason as caused them to leave the first nest. November 14th, saw the same pair at work on a fresh site on the south wall of the same cottage, darting upwards from a convenient rail five and six times in a minute, till the hard plain surface of the wall was broken by the dig of the bill. This was the difficult commencement of their toil; here was no foothold, the beak served as a pick, and a separate dart upwards had to be made each time this pick was applied. Alas! their labour was again lost, three more holes were begun and partly completed in that wall; then this indefatigable pair went over to the opposite end of the cottage, and, in the chimney-wall they had first attacked, commenced another nesting place; this was the seventh attempt on November 26th. On December 4th this contained two eggs, on the 7th five eggs. The nest was visited, always by the same person, on the the 9th, 16th, and 23rd; on the 25th there were five young ones, apparently hatched on the previous day, thus allowing seventeen days for incubation. From the state of the tunnel the bird fed or was fed during incubation.

When a fortnight old the young look very strange, they have a dim show of the colours of the old birds, but the feathers are in their sheaths over their whole bodies, so that they look prickly all over; irides dark brown, almost black, the bill black with white tip to the upper mandible. On the twenty-fourth day the young left the nest, dashing out of the hole and covering quite 200 yards before seeking a perch. This occurred on January 8th so that most of the heavy labours of the birds, which commenced on or before the 19th of October, are now over, as the young are able to follow their parents to the feeding ground.

Here a very interesting question rises. In what state was the ovary of this hen bird during the protracted labours of nest building? What limit is there to the power of retention? as during a space of about six weeks, judging from the almost finished state of the nest, she was three times ready, or nearly ready, to deposit her eggs.

We found the halcyon scarce through some part of Westland, from Hokitika south to the Waio River; the note was only heard, or the bird seen, twice or thrice near the rivers Waitaroa and Okarito. Inland from the coast we have met with it as far back as Castle Hill, near Porter's Pass; this was at breeding time (December 6th). It is during this all important season that these, our silent birds, change their habit so much as to become really noisy; so many varying calls or cries are used that one accustomed to their society could tell of much they might be engaged in, even with his eyes shut. Their boldness in driving away intruders from their young is most conspicuous. The hen bird will often meet a person some two or three hundred yards from her treasures, dash at the intruder, return to the place where the young are

perched, and repeat the attack again and again. We have known it attack and drive back a dog; in the autumn, when the old birds are accompanied by their young, boldness seems mingled with mischief or humour. We have seen a group of fine pigeons sunning themselves whilst preening their feathers on the roof of our village parsonage, in an instant scattered to the winds, as one might say, by the sudden dash of a mischievous kingfisher, with no other apparent object than to excite their alarm. We have noticed sheep and cattle grazing close to a nest without causing any anxiety to the birds, yet a cat, dog, or human being, would be immediately attacked. We have seen our handsome butterfly (*Pyrameis*) sunning itself unmolested just above a nesting hole at which a pair of kingfishers were at work, yet after the young had flown we found the bottom of the chamber covered with remains of thousands of insects, including the gauzy wings of our largest dragon-fly.

At Ohinitahi, in the breeding season of 1871, we knew of three nests containing in each seven eggs, one nest with six, and another with five eggs.

No. 12.—Anthornis melanocephala, *Gray.*

The nest and eggs of this species, collected in the Chatham Islands, has been recently added to our collection in the Canterbury Museum.

The structure of this nest does not show much likeness to that of *A. melanura*, the foundation being laid with a well interwoven mass of bent twigs and roots, on which is built a round nest composed chiefly of leaves of coarse grass, which are twisted into a symmetrical shape; the interior of the cavity has a few tufts of wool, which are not woven into the fabric; a few feathers, sparingly introduced, completes the nest, which has the following dimensions:—From outside to outside of wall, 7·5 in.; diameter of cavity, 2·5 in.; depth of cavity, 2 in.

No. 16.—Xenicus longipes. *Gml.*
Huru-pounamu.
Green or Striped-faced Wren.

The green wren, with its confident habits, is a lively object in the sombre woods of the back country; it may be found in the *Fagus* forests which clothe the bases of the mountains that confine the Wilberforce, Havelock, and other snow-fed streams, frequenting the outskirts of the bush.

We have found that a very poor imitation of its note brings it close enough for observation, for within a yard's distance it will often pursue its restless insect search, apparently indifferent to the presence of an observer. Its time is chiefly occupied with minute investigation of the lichens and mosses that decorate and partially clothe the undergrowth of the forest, especially we have seen it busily engaged where the level velvety surface of the ground has been disturbed and upturned by the strong claws of the wood-hen (*Ocydromus*).

On a visit to the Rangitata glaciers, late in the month of December, the writer was lucky enough to find the nest, perhaps one of the most difficult to discover amongst those of our native arboreals; this is owing to the perfect manner in which the structure is hidden amidst surrounding moss.

The nest was discovered just within a mixed bush of totara, ribbon-wood (*Plagianthus*), and birch, far up the Havelock. Beneath the moss-covered roots of one of the ribbon-wood trees was fixed the nest, which was pouch-shaped, with the opening near the top; the sides of the entrance being strengthened with fern-root, carefully interlaced; indeed, it was almost wholly composed of fern-root, beautifully interwoven; and the interior was furnished rather profusely with feathers. It was so well concealed, that it was with difficulty believed to be a nest at all, the entrance being scarcely discernible. It measured about 3·5 inches in depth, by 3 inches in breadth; entrance, 1·5 inches; depth of cavity, 2·5 inches.

The call of the green wren is a sharp cheep; not so shrill as that of the brown creeper (*Certhiparus*), yet much more powerful than that of the little wren-creeper (*Acanthisitta.*)

No. 19.—ORTHONYX.

The writer, after careful comparison of a series of nests and eggs of *Orthonyx*, is inclined to believe that the two species are less closely allied than is usually supposed. With respect to the colour of the eggs of *O. ochrocephala*, the writer informed Dr. Buller that white with red marks was not a satisfactory description; white, washed or clouded with yellowish brown, would more accurately describe their colour. We have nests and eggs from Okarita and Ahaura, in Westland.

No. 20.—SPHENŒACUS PUNCTATUS, *Quoy*.

We found the nest of this bird last December, at the margin of the Okarita lagoon, Westland.

No. B. 24.—GERYGONE SYLVESTRIS. n. s.

The writer sent the following description to the "Ibis," of a *Gerygone* which affects dense bush near lake Mapourika, Westland. His attention was attracted to the bird by its peculiar song, which differs from that of *Gerygone flaviventris*.

The editor of the "Ibis" supplies a note, in which he states that Dr. Buller believes this *Gerygone* to be *G. albofrontata*, Gray. Dr. Buller does not assign his reasons for this belief, neither does he give any account of the song, or habits of *G. albofrontata*. I, therefore, confidently bring this species forward for the consideration of New Zealand observers, and apply the specific name of *sylvestris* as indicative of its habits.

"The habitat was unusual, *in the thick bush*, between the bluff of Okarita and lake Mapourika; whereas our little riroriro delights in trilling from the shrubs on the creek-side, or more open country, or in flitting about the bushy vegetation of the gullies that fringe or form the outskirts of a forest. Neither my son, who accompanied me, nor myself had ever heard a similar note; with diffidence we set it down as a new species. For the next few days, whilst rambling in that locality, we heard the same note repeatedly, and saw the birds, but we never observed one of them on the outside of the bush.

"The diagnosis of a male bird, killed 20th December, four miles west of lake Mapourika, is here given. This bird was in full song. Upper surface dark olivaceous; wings smoky black, except first two feathers, outer webs fringed with yellow; cheek dark grey; neck and breast pale grey; abdomen white; under wing-coverts white; upper wing-coverts brown, margined with yellow; upper tail-coverts slaty black, tipped with yellow; tail brown, with a broad band of black, two centre feathers black, tipped with brown, four feathers on each side tipped with white on inner webs, pale brown on outer web, two outer feathers broadly barred with white, tipped with brown.

"Bill black; both mandibles horn-colour at the point; legs and feet black; inside of feet yellowish flesh; irides bright blood-red.

"Bill from gape, 6 lines; wing from flexure, 2 inches; tail, 2 inches 2 lines; tarsus, 9 lines; middle toe and claw, 5 lines; total length, 4 inches 5 lines."*

No. 26.—Certhiparus novæ-zealandiæ, *Gml.*

Brown Creeper. (Plate XVII.)

An illustration is given of the nest of this species, as it has been but seldom observed, notwithstanding that the bird is of common occurrence in the bush. We noticed this species in the Westland forest, from the Teremakau to the southern Waio. It frequents the Irishman scrub (*Discaria toumatou*) on the upper Rangitata river; this habitat is little sheltered, and appears rather peculiar considering the habits of the bird.

No. 35.—Zosterops lateralis, *Lath.*

Blight Bird.

From observation of an egg taken last summer, the writer is in doubt whether this immigrant has not become the dupe of the whistler (*Chrysococcyx*).

A nest was found, built in a manuka bush (*Leptospermum scoparium*), containing four eggs, one of which greatly exceeded the others in size, and was of a deeper blue-green colour. This incident bears upon a very interesting and much discussed question as to protective mimicry by parasites of the eggs of dupes, by approximate colouration. The nest and eggs are deposited

* "Ibis," July, 1872, p. 325.

in the Canterbury Museum. This summer the blight bird is far less abundant than it has been for several years, the exceptionally severe winter of 1872 having greatly diminished its numbers. Birds of this species, dead and dying, were often observed after storms of snow-sleet, or even cold rain; this tenderness of constitution is a strong argument in favour of the opinion of the writer, that the *Zosterops* is but a recent settler amongst us.

No. 36.—KEROPIA CRASSIROSTRIS, *Gray.*
Pio-pio.
Thrush.

[*Notes of a Paper forwarded to the Linnæan Society.*]

In writing on the natural history of our birds, the bewailment of their lessened numbers has come to be a matter of course, the rapid settlement of the country has, in the case of the thrush, limited its range greatly, few birds having retreated with so much haste before the efforts of the cultivator.

Let us take a section of this island, say one hundred miles in width, including Banks Peninsula, and stretching from the eastern to the western shore, this will afford some information as to its present habitat.

Within this range at one time, the pio-pio might be found in any bushy place, not too far from water, where belts of shrubs afforded shelter and abundance of seeds; ten years at least have passed since we heard of its occurrence in this neighbourhood (Governor Bay); on Banks Peninsula proper it is now scarce; in the bush-dotted gullies of the Malvern Hills, the Thirteen-mile Bush, Alford Forest, and many other localities, it was not very uncommon; now, let an enthusiastic naturalist traverse these places in quest of our feathered philosopher, he will find it has become a *rara avis* indeed.

We must pass through these portals of the mountains, the river gorges, to catch sight of the thrush hopping about the openings of the bush, much after the fashion of its English namesake; but even here its numbers have become woefully diminished; four or five years ago, on either side of the Upper Rakaia, where the bushes descend the mountain slopes, these birds fairly teemed in their favourite haunts, but they are already becoming rare. They may be seen about the bushes that skirt the cold streams of the Havelock, the Upper Waimakariri, and the Bealey; through the romantic gorge of the Otira to the more level ground that stretches away to the Teremakau it may be frequently seen, always appearing to prefer the timbered forests, the mixed scrub, made-up of moderate sized bushes of *Coriaria, Olearea, Veronica,* and *Coprosma.*

As we reach the western coast, about the Arahura river it was, three years since, most abundant. Last December we searched one of their former favourite haunts, a large island in that river more or less covered

with scrub-bush, dotted with ti trees, and two or three specimens only were to be seen; they have been driven away from Arahura by the clearances for paddocks to supply the requirements of the West Coast cattle trade.

Last December in travelling along the coast from Ross to Okarita, we saw this bird in abundance on the face of those bluffs which form such picturesque breaks in that journey; up the river flats it was equally numerous.

Settlers have given the name of the thrush to the pio-pio, from its size and brown plumage recalling to mind their favourite of the old country; it possesses not in the slightest degree that charm of song which distinguishes the throstle, yet it enjoys the power of giving utterance to several pleasing notes. It does not stir so early as many other birds; its morning salute is a long-drawn rather plaintive note; this peculiar whistle it indulges in at times only, for its habit, when close to the water frequently, is to pipe thrice, in a way that at once recalls the red-bill (*Hæmatopus*); the imitation is so like, that the writer and his son (well acquainted with bird-notes and calls) were frequently deceived, and have looked for a red-bill till the pio-pio disclosed himself by fluttering from bush to bush. Its common song seems to be near akin to that of the lark (*Anthus novæ-zealandiæ*); it sounds two preludatory notes, then strikes off into a very brief song; when joyously flying in pursuit of the female it utters a quick chi-chi-chit, chi-chi-chit; it marks its displeasure, or tries to intimidate intruders that approach its nest, with a low purring chur-r-r; both cock and hen join in this cry of anger. When singing, the effort is marked by the tail being spread, the wings held not quite close; the feathers of the breast and back are not raised as in the case of the bell-bird.

We have called this pio-pio a philosopher; he has quite as good a claim as many a biped to whom that title is accorded; who doubts this, let him make acquaintance with the pio-pio; not merely a sight acquaintance, but such an one as ripens into intimacy. The result will be to know a bird who takes the world as it is, indifferent as to food; that feeds on insects when procurable, or can make shift on grasses, seeds, or fruits; that neither courts nor avoids observation; is as bold as the robin or tit, without their intrusive friendliness; that, when in the presence of strangers, coolly pursues its occupation without the prying inquisitiveness of the brown-creeper, or the watchful distrust of the popokatea; that defends his home with almost the courage of the falcon or tern.

It seems to delight in those openings which are found in river-beds, between long belts of tutu and other scrub; there it may be observed either hopping along the ground or fluttering about the lower sprays of shrubs, flying out to the spits of sand, or drifted trees, that lie stranded in the river-bed. On some of the longer formed spits, that are becoming clothed with vegetation, it searches amongst the burry *Acæna*, snips off the fruit stalks of

moss, picking the seed of some trailing *Veronica.* Its progress on the ground is usually deliberate; it hops with both feet together, a slight flutter of the wings, and a flirt of the tail accompanying each motion; when approached too closely, it leaves its perch, always descending at first, as though safer when near or on the ground; if it would rise on the wing, a momentum is gained by a succession of hops. In some of its habits one is reminded much of the wattle-bird; its usual associates, at any rate during the summer months, are tuis, parroquets, and robins.

Not much secretiveness is displayed in the choice of a site for its nest; it may be found at varying distances from the earth, from four feet to twelve and upwards, usually at seven or eight. The structure is firmly and compactly built, with small sprays for the foundation, on which moss is abundantly interwoven with pliant twigs; the lining is usually of fine grass bents; some nests are finished off with soft tree-fern down; it is usually placed in tutu (*Coriaria ruscifolia*), sometimes in *Coprosma*, or manuka. From the neighbourhood of its home, rivals of its own species as well as other birds are driven off.

Probably it breeds twice in the season, although we have not observed more than two eggs to a nest; yet we have found four eggs tolerably forward in the ovary of a female killed at Christmas time. The full complement of eggs is probably four. The egg is of ovoid, sometimes elongated form, pure white, spotted with blackish brown or black, purplish at the edges of the spots; sometimes it is of a delicate pinkish tinge, just staining the white, spotted with brownish grey, with purplish blotches at the larger end.

From a nest found at Arahura we have an egg that exactly resembles in its colour and markings that of *Oriolus gallula*, of Europe. In size this specimen measures through the axis 1 in. 3½ lines, with a diameter of 11½ lines.

NOTE.—December 26th, River Waio. In a nest, about 12 feet from the ground, in a bush of *Coriaria*, the eggs, two in number, were of elongated form, and measured in length 1 in. 7 lines by nearly 1 inch in width.

December 27th, River Waio. A nest in a small-leaved *Coprosma* (probably *rhamnoides*); hen incubating a single egg; she remained on the nest till pushed off. The cock bird was summoned by a jarring call, and both birds joined in a bold defence.

Near Lake Mapourika, in a very swampy situation, we found a nest with the walls very thickly built of moss and manuka sprays interwoven, it was placed about 15 feet above the ground in a tall manuka. Dimensions of the nest across the top from outside to outside of wall about 7 in., diameter of cavity about 3 in., with a depth of 2 in. We find this a fair average after looking at scores of nests. The young when they emerge from the shell have a covering of dark down. We think the eye of the pio-pio gleams with much

intelligence; perhaps this notion is conveyed by its narrow, but bright pale yellow iris; the tongue is pointed, and furnished on the inferior side with a strong muscular process of almost horn-like consistence. Both skin and flesh are dark, but the flavour of the bird is not at all bad. It makes a savoury broil for those who bring the proper (hunger) sauce; when not so provided they do wanton mischief who kill a bird so harmless and interesting.

They are very sociable, and a bush-hand, living the life of a hermit in his little whare of tree-fern stems, up the Waio river-bed, fed some thrushes until he had enticed them to enter his hut. Once up the Havelock in one of the outskirts of a mixed bush of *Phyllocladus*, *Fagus*, and *Podocarpus*, several thrushes were observed flying from the top of a tree after insects, fly-catcher fashion, in the glow of a hot afternoon.

The writer inclines to the belief that the imitation of the red-bill's note, above alluded to, is a good instance of the protective mimicry of sound. The pio-pio gets ample food, in the summer days at least, from the glades in the river beds. Over these, high above, dash the falcons from amongst the rocky heights of the mountain chain; the hawk notes the movement of a bird below, but hearing the simulated cry of the red-bill, withholds his dashing swoop, knowing that the wary red-bill will alarm his faithful mate, and that the pair, with forces combined, are not to be attacked with impunity.

No. 37–8.—Rhipidura.

Fantails.

Dr. Finsch states, "All the specimens I have seen showed not the slightest sign of a white spot above the eye." The black flycatcher, with the white spot, is not uncommon about Ohinitahi. Specimens could be procured without difficulty. The writer has called the attention of ornithologists to the fact of the interbreeding of the black with the pied species (*Trans.* N.Z. Inst., Vol. II., p. 64). Such joint nests, with eggs, have been placed in our collection in the Canterbury Museum. To those who take an interest in bird architecture these exhibit features of great interest; the writer has pointed out a peculiar style of construction which sometimes marks the work of *R. flabellifera* in order to meet the conditions of certain positions; in an union nest where the hen bird was a *flabellifera* the domestic structure showed the influence of her instinct by the affixing of the appendage used, as the writer believes, to steady the nest in very good positions for a food supply for the young; but at the same time these sites are affected, perhaps, by sudden draughts of air or puffs of wind. Now, the question is whether a pair of *R. fuliginosa* would have ventured to build a home in the position chosen by the union nest builders, not possessing the superior intelligence of the pied species? As far as our observations of some years are of value they would not, neither would

an union nest be so constructed unless the hen happened to be a *flabellifera*. Thus, in course of time, as the *flabellifera* could live well where *fuliginosa* would not attempt to rear their young, the pied should outnumber their black congeners.

NOTE.—October 29th. The writer has seen what he took for *R. flabellifera* attending and watching three young birds, well able to forage for themselves. These, to all appearance, were *R. fuliginosa*, blackish, or very dark olivaceous brown; head, greyish shade of black; neck, slaty black; bristles at the base of the mandible grizzly, or silvery black.

Further observations will be necessary to clear up some very interesting points in connection with this fact.

No. 45.—CREADION CARUNCULATUS, *Gml.*

Tieke.

Saddle-back. Pl. XVII.

The saddle-back, which a few years since was commonly met with in the more thickly wooded portions of Banks Peninsula, is now of rare occurrence there. The extensive area of growing timber at the Little River Bush will probably be its last refuge in that part of the country, so rapidly is the Peninsula becoming disforested. Although we have met with, and have known of the nest of this striking looking bird in the more open parts of the forest, yet it seeks and loves the shady covert of the densest bush, where decaying tree and damp mosses conceal an insect food supply. It does not appear to be strong on the wing; we have never seen it attempt a lengthened flight, yet its movements are notably prompt, rapid, and decided. It usually announces its sudden approach by a shrill note unlike that of any other bird we know; it sounds like "chee-per-per, chee-per-per," repeated several times in quick succession. No sooner is this call-note heard than the bird emerges from its leafy screen and bounds before the spectator as suddenly as harlequin in a pantomime. From these abrupt movements, or flying leaps, thus shrilly accompanied, it seems to perform a *rôle* of its own that appears almost startling amidst the umbrageous serenity of the forest. Let the eye follow its motions, that are so quickly changed, and watch the tieke perched for a few moments on the lichen-mottled bole of some fallen tree, a favourite position—its glossy black plumage is relieved from sameness by the quaint saddle-mark of deep ferruginous that crosses its back and wings, the red caruncles add much to the sprightliness of its air; the observer will probably notice that its attitude is peculiar, or, in colonial phrase, "it has a queer set on it." The head and tail are kept rather elevated, the feathers of the tail take a gently sweeping curve, the bird looks as though prepared to leap, one more glance and it is away, climbing some moss-clothed trunk, or picking its

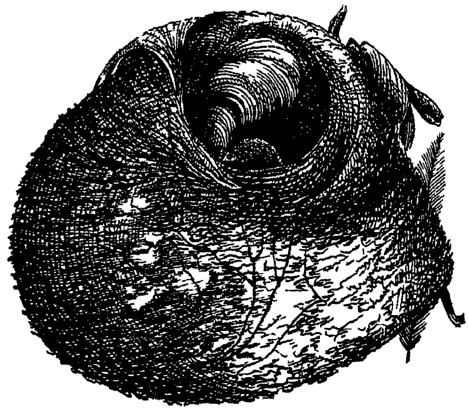
food from beneath the flakes and ragged strips of bark that hang from the brown-stemmed fuschia tree. It must be an early breeder. On the Teremakau we have seen the young, almost of adult size, in the first week of December.

For its nesting place a hollow or decayed tree is usually selected, sometimes the top of a tree-fern is preferred. The first nest we knew of was found by an old friend in a hole about four feet from the ground in a huge white pine, kahikatea (*Podocarpus dacrydioides*), close to the bank of the Ahaura river; it contained three eggs hard set. We found a nest in a dead tree-fern not far from Lake Mapourika, Westland. This was of slight construction, built principally of fern-root, deftly woven into rather a deep-shaped nest with thin walls; as the structure just filled the hollow top of the tree-fern thick walls were unnecessary. Another nest, in a small-sized decayed tree in the Okarita bush, was in a hole not more than three feet from the ground; it was roughly constructed, principally of fibres and midribs of decayed leaves of the kiekie (*Freycinetia banksii*), with a few tufts of moss, leaves of rimu, lined with moss and down of tree-ferns (*Cyathea*); it measured across from outside to outside of wall 12 in. 6 lines, cavity 3 inches diameter, depth of cavity 2 in. The egg, measuring nearly 1 in. 4 lines through the axis with a breadth of $11\frac{1}{2}$ lines, is white, sprinkled over with faint purplish marks, towards the broad end brownish purple, almost forming one large blotch. The breeding season probably extends from September to January; the young are protected and fed by the old birds till almost full grown; they are summoned by the parent birds with their usual call, nor from this does the note of their active offspring greatly differ; the saddle-back quickly responds to the summoning note of its species. An imitation of the sound by the assistance of a leaf between the lips serves to attract its presence, and is sometimes used by the collector for this purpose.

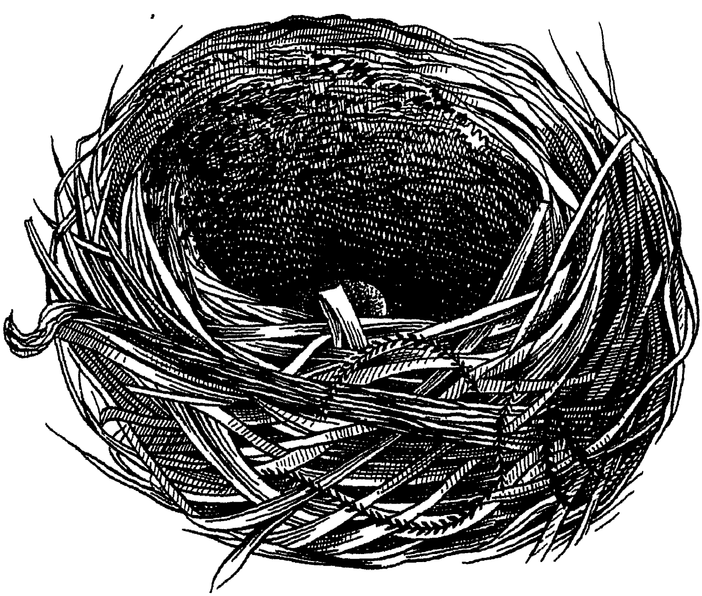
The next point to be considered is the plumage; that of the adult is easily described, for the feathers of the sexes fail to exhibit any distinction. The collection in the Canterbury Museum contains numerous specimens in the young state, procured at different seasons of the year:—

A.—Female obtained on Banks Peninsula, in the month of March (our autumnal period), has the whole plumage cinereous brown, slightly flushed with rufous, excepting bastard wing and the inner webs of the tail-feathers which are black; outer wing-coverts margined with ferruginous; upper and under tail-coverts ferruginous; wattles very small, pale yellow; mandibles black, except the edge of the basal portion of the lower mandible, which is margined with yellow for a distance of 6 lines; tarsi and feet black; claws horn-colour; length of bill from gape 1 inch 4 lines.

B.—Male killed at Little River Bush in November (early summer), differs



NEST OF
CERTHIPARUS NOVÆ-ZEALANDIÆ, Gml.



NEST OF
CREADION CARUNCULATUS, Gml.

J.F.McCardell del. J.B. lith.

but little from the preceding specimen, except that the caruncles are more developed, and the bill is longer by 2 lines.

C.—Male obtained in the bush near Akaroa, in August (the last winter month), has a warmer tinge of ferruginous flecked on the interscapulars and dorsals.

D.—Female, procured on the same day at the same locality, differs only from specimen A in being less warmly tinted with rufous.

E.—Male, killed near Akaroa in the same month (August), has the interscapulars and dorsals margined with rich ferruginous; the yellow edge on the basal part of lower mandible indistinct.

F.—Male, obtained on Banks Peninsula in March, has the growing secondaries and rectrices black; a sprinkling of the same colour on the auriculars; upper wing-coverts, dorsals, upper and under tail-coverts, ferruginous. It may be noted from the description of these specimens of the young state, how much variation may be met with, owing in part to the extended breeding season perhaps; and it may be that the adult state is not arrived at till the second year.

The plumage of the adult bird is deep glossy black; back, wing-coverts, upper and lower tail-coverts, ferruginous; bill, tarsi, and feet, black; irides dark brown; caruncles from yellow to red; bill from gape, 1 inch 5 lines; tarsus 1 inch 6 lines; wing from flexure 4 inches; tail 3 inches 6 lines; total length 10 inches; weight $2\frac{3}{4}$ ounces.

The ticko abounds in the Westland bush, its note is there one of the common bird sounds; it finds abundant means of support in the insect life which exists out of reach of the kiwi. Last season, my friend revisited the kahikatea on the bank of the Ahaura, but the saddle-backs had not again resorted to the hole for breeding.

A sketch of the nest is given, as it may be deemed interesting; there is nothing strikingly characteristic about its construction.

No. 50.—PLATYCERCUS.

Parroquets.

Specimens of a red-headed parroquet have been obtained from Bealey, which are not larger than *P. auriceps*. They appear not unlike some specimens of *P. alpinus* that Mr. Bills procured in Otago last year.

No. 60.—COTURNIX NOVÆ-ZEALANDIÆ, *Quoy*.

Quail.

Eggs from one of the natural paddocks or grassy spots near Hokitika, Westland, rather exceed the dimensions of those that have been procured on the eastern side of the ranges.

No. 61.—Apteryx australis, *Shaw.*
Rowi of the natives.
Big Kiwi of the miners.

Why should there yet be so much mystery about the habits of birds so well known as kiwis? Their flesh has for years been recognised as forming a part of the bush-food of the prospector or digger in Westland; just as much so, indeed, as that of the pigeon, the weka, or the kaka, still we have not any minute history of this quaint-looking creature.

There are, in the writer's opinion, probably five or six species of *Apteryx*; of these, all but one are supposed to exist on the South Island, whilst *A. mantelli* is now the sole representative of the race in the North Island.

The rowi, or big kiwi of the west coast of the South Island, is far more local in its distribution than is *A. oweni*, or even perhaps than *A. mantelli*; according to Mr. Docherty, it is known to inhabit certain districts, the well-defined boundaries of which it does not attempt to pass; its range is as isolated and distinctly marked as though impassable barriers existed between its haunts and the surrounding country.

We have had many opportunities of watching the mode of progression of three kinds of kiwi, and of judging of the defensive powers of the bird, supposed to be conferred by the robust tarsus and foot, which have gallinaceous characteristics much more prominent in life than in the best preserved specimens. The articulation of the tibia with the tarsus is one of great strength; the powerful scale-defended leg is united to a foot furnished with strong claws, with which the bird scratches for its food, after being directed thereto by its powerful olfactory organs. We believe that the beautifully organized bill (which should be observed in life to understand its delicacy) is used solely for probing into soft humus, moss, and decayed wood. When the rowi is irritated it makes a cracking noise by snapping the mandibles together very rapidly. In attempting to defend itself it displays an awkward feebleness rather than a posture of self-protection, by striking forwards with its foot, as in the act of scratching, at a line about its own height, and its only defence against dogs is in concealment. In walking the step is peculiar, the foot is lifted deliberately, and rather high above the ground; its gait reminding one of the movements of a person walking stealthily. Its run is a slinging trot, but in fairness it should be remembered that our judgment of its locomotive powers is based on the blundering efforts of the wretched animal half-blinded by the unaccustomed glare of daylight, or frightened and dazzled by artificial light at night.

There are a few other points in its organization which must be taken into consideration. In the first place the feathers are soft, flocculent, and silky towards the base, whilst the distal portions terminate in produced hair-like

webs, the plumage consisting simply of clothing feathers, which during the progress of the bird give out no sound of fluttering or rustling. This peculiarity of the plumage confers another advantage by its compressibility, whilst it can be kept far cleaner than the integument of birds having feathers with closer vanes, interlocking barbules, or thicker down, as with this hair-like dress a single shake rids the bird of every foreign particle, while the feathers, covering the body like a thatch, effectually keep off the wet of the ever humid ferns and mosses among which the bird lives. If an *Apteryx* be plucked its body will be found somewhat conical from the point of the bill to the thighs, a form well devised for gliding through the thick ferny bottoms choked with the heavy fronds of *Todea superba* or the close trailing folds of *Freycinetia*, and enabling the long bill to be used to the greatest advantage in exploring deep but narrow fissures about the roots of trees.

It is probable that the rowi pairs for life, for there appears to exist between the sexes a lasting companionship. For a nesting place it selects a hole in some huge tree or log, or amongst roots; sometimes the hole is excavated in a soft bank, where the soil is light; but in every case care is taken that the site shall be on a ridge or dry ground. We examined a nesting place on the 17th December last, which was tunnelled in a mound of light earth, probably formed by the uprooting of some forest giant; the entrance was 9 inches in diameter, a chamber was found to be excavated to the left of the entrance, from this to the back of the chamber was a depth of 3 feet, with a height of 15 inches. This retreat had been abandoned by the family, but we picked pieces of egg-shell from the floor.

The breeding season extends over some months, from October to February. Two eggs are usually laid, on which the old birds rather lie than sit. The mode of roosting is very peculiar; they squat opposite each other with their legs bent under them, each with its head tucked under the scanty apology for a wing. If there are young in the hole they also assume a similar position, on either side a young bird between the two parents, thus the result of this singular arrangement of the family is a nearly perfect hemisphere of feathers. They often appear torpid or very drowsy when surprised in their homes, sometimes remaining quite undisturbed by noise, and are very rarely discovered except in a hole. In good condition a bird will average from 5 to 6 lbs. in weight.

Their cry is much harsher than that of the kiwi, sounding something like "cr-r-r-ruck, cr-r-r-ruck," and is not uttered till after sundown; from timed observations in the bush we noticed that when the sun set about 7.30, we did not hear the rowi till from 8.15 to 8.30.

The young are well clothed when they leave the shell; with them the bill is not curved, following the ridge of the upper mandible it is slightly depressed about the middle of its length. The general colour of *A. australis* is greyish

brown, streaked with black in the young and adult state; in some fine old birds a glint of golden chestnut edges part of the plumage. Not unfrequently specimens have the aural feathers of dull yellowish white or grey, the same hoary tone of colour being sometimes found on the occiput, chin, neck, and front of the thighs. These marks are not confined to sex.

In giving measurements of species where an extensive collection yields an ample series from which selections can be made, care should be taken not to give dimensions of extraordinary specimens unless that fact is duly noted. A fairly average pair of *A. australis* from the Canterbury Museum afford the following measurements:—

	Male.		Female.	
	In.	Lines.	In.	Lines.
Bill from gape	4	6	6	4
Tarsus	2	8	2	11
Middle toe and claw	2	9	3	0
Length	21	9	25	0

These specimens were obtained by Mr. Docherty, together with a large number of others, both of *A. australis* and *A. oweni*, from the West Coast, near Okarita.

We cannot conclude these notes on *A. australis*, the big kiwi, without expressing our sorrow at the impending fate of this interesting bird. It is rapidly becoming rare from the demand for specimens for collections; the number of skins and skeletons received at the Canterbury Museum alone is very great, and nothing but prompt action will save the rowi from extermination.

No. 62.—Apteryx oweni, *Gould.*

Kiwi.
Straight-billed Kiwi.
Grey Kiwi.
Blue-hen of diggers.

As far as we are aware the habits of the straight-billed kiwi do not differ greatly from those of the rowi, or, perhaps we might safely say, from those of other species of *Apteryx*, due allowance being made for local influences.

The long, nearly straight bill of the kiwi is used in a similar manner to that of the rowi, and in dried specimens is of a dark horn colour, or at times resembles yellowish ivory, but in life is of a flesh colour, pale almost to whiteness, the minute blood vessels of its delicate membranous covering imparting a pinkish tinge to its distal end, and a perfect network of minute veins traverse its entire length from the point to the soft bristly integument which clothes its base. About eight lines above the truncated knob of the upper mandible these minute vessels assume a stellate arrangement, from

which their delicate ramifications appear to issue. We have observed that the double linear impression on the upper mandible is not always constant, as in some specimens the groove deepens into a single line as sharply defined as though marked by a scribing tool. The lower mandible is also furnished with similar minute blood vessels, most densely crowded towards the point. On the deflected tip of the upper mandible is an impression which in some birds is nearly circular; others have this mark of almost angular shape. It is probable that a great degree of sensibility is conferred on the elongated bill by its investing membrane, so that the movements of insect prey are readily followed. We can see no reason for mistaking this elaborately organized bill for an instrument to be used like a pick for digging into hard soil, and we doubt if the kiwi ever leaves the shelter of the bush. The tongue is very short but muscular, of angular shape, and can be used in crushing insects against the flat opposed surface of the upper mandible, as the strong muscle on the lower surface gives a great degree of strength.

The visual organs, which are feebly developed, are placed so as to command the movements of the upper mandible, and are protected by stiffish ciliæ; the ears are well developed, and as an aid in discovering food are next in importance to the olfactories. The long straggling hairs, or weak bristles, planted amongst the feathers of the anterior part of the head. fulfil the useful office of protecting the eyes and head from injury; they may also guide or regulate the force of the thrust given by the bill. In life a perfect guard of feelers, they form a simple kind of defence, in strict harmony with the natural instinct of the kiwi—that of retiring cautiousness. The tarsi and feet, described as yellowish brown in life, are often as white as those of thoroughbred Dorking fowls, though now and then specimens will show a darkish tinge that stains the edges of the tarsal scales. The under surfaces of the feet are well protected by cushions; the claws, slightly curved, are sharp at their points, admirable for scratching, yet they are not shaped like those of the domestic fowl, which are adapted for traversing hard ground as well as for that purpose. The robust tarsi, defended by hard scales, are articulated with the tibiæ by very strong joints, which must give to the kiwi great power of leaping or jumping, and thus enable it to scale fallen trees and search along their upper surfaces for insects. The hind toes and claws help in maintaining the position of the bird when fossicking about the prostrate trunks, strengthening the hold, and preventing it from slipping to the ground when reaching down.

The cry of the kiwi is not heard till nightfall, or, as the digger expresses it technically but truthfully, "not till the night shift comes on." We have paid great attention to the call; to us it sounded like "kvee, kvee, kvee," repeated sometimes as many as twenty times in succession, with moderate haste; we noticed that the cry had scarcely ceased before it was thus replied to

"kurr, kurr, kurr." These calls were heard through the night, commencing sometime after sundown and ceasing about three o'clock in the morning; we never heard a call after dawn.

The breeding season extends over several months; eggs have been obtained on the West Coast during a great part of the year. The home is to be found usually beneath the spreading roots of trees, in logs, or under rocks, and will contain sometimes one or two eggs or young, but never more. The nests are found on the bare soil, and are never constructed of dried fern and grasses. The pair of birds usually remain together during some months and share the labours of incubation, but the male apparently allows much of the labour of rearing the young to devolve on the female. The young have been found at a short distance from the family abode—in a nursery in fact. They are quaint looking little animals, with not too much of the savour of youth about them, being nearly exact miniatures of the adult; that well known ornithic characteristic—change of colour—troubles them not; there is no young state of plumage with them, none of that half-pronounced variation in tone, or tint of colouration, which calls for the nice discrimination of the practised ornithologist when questions of age have to be settled. They assume not seasonal distinctions of dress; in winter and summer they adhere to their sober colours with quaker-like pertinacity.

The separate lodging is probably not set up till the young are well able to forage for themselves under the guidance and protection of the old birds; the family party is not necessarily broken up, because all its members do not abide together in one place of hiding and rest. There does not appear to be any reason for believing kiwis to be great travellers, ample supplies of food are to be obtained by fossicking around their homes. Judging from tracks, they appear to resort to the same holes for some time, probably till the family has consumed the more favourite kinds of food in the vicinity. Kiwis seem to adopt the same squatting posture as the rowi, and are quite as lethargic, suffering themselves to be captured without any other resistance than a feeble struggle, in which, at worst, a scratch or two would punish incautious handling. As for defence, the domestic cock or hen would be terrible as "a raging lion" compared to this harmless bush fowl.

They suffer from at least two races of parasites.

Note.—December 17th. Took a kiwi out of a log, very white skin, legs, and feet; it was infested with a species of *Pediculus*, sandy in colour, and remarkably active in its movements; immediately below the chin hung a slatish coloured species of *Acarus*, which maintained a very firm hold, and was dislodged with difficulty.

Sometimes the kiwi has been found very high up on the ranges, not very far below the snow it is said, but always in the bush.

NOTE.—December 24th. Took a kiwi from rather a deep hole beneath a fragment of rock, just within the scrub bush, about a mile westward of the Franz Joseph glacier; about two miles further to the west, near the north bank of the Waio river, found a pair of kiwis in a hole under the roots of a large konine (*Fuschia excorticata*).

This pair of birds gave the following measurements :—

	Hen. In.	Hen. Lines.		Cock. In.	Cock. Lines.
Bill from gape	4	3	...	3	6
Tarsus	2	6	...	2	2
Middle toe and claw	2	6	...	2	6
Total length	18	0	...	17	6

It will be observed from these dimensions that the hen slightly exceeds the cock in size, and that this disparity is most noticeable in the length of the bill. It is also commonly said that the female kiwi is the larger bird, and dissection of several specimens confirmed this statement. In all cases we found the gizzards to contain a very considerable quantity of rough pieces of slate and quartz, also rarely a few very hard seeds. These stony fragments in a fair average gizzard weighed as much as 114½ grains, five of the largest pieces weighing about five grains each. We believe the hard seeds had not been picked up for food, but for the purpose of trituration, probably in some locality where bits of stone were rarely met with.

When the kiwi is deprived of its skin or feathers, immediately below the lower neck on each side at the base of the wings, there may be noticed a rather angular-shaped protuberance not unlike the mamma of certain animals. These are adipose deposits of very firm texture, which we incline to believe are of material assistance during incubation. The difficulty that has been felt in understanding how an egg so disproportionate in size can be successfully hatched by a bird not larger than an ordinary barn-door fowl has led to many curious surmises. According to Mr. Docherty the kiwi, with her egg deposited on the bare soil, proceeds with the labour of incubation by arranging the egg between the feet, its axis or long diameter being kept parallel to the body. Now, the keelless sternum being laid on the egg, with the præpectoral masses of fat pressing on its oval sweep between the bilge and blunt end, may it not be inferred that its monstrous bulk is thus kept from slipping, while receiving its due supply of heat. Being easily turned by rotary motion initiated perhaps by the feet, the warmth derived from these fatty tumours also makes up at one end of the egg for the entire covering of the opposite extremity by the body of the bird, and thus equalizes its temperature to a certain extent. The kiwi, when relieved by its mate, or when resuming its sitting attitude after food search, would but have to reverse the position previously

maintained, in order to distribute over the entire surface of the egg a fair and equal amount of heat. The sitting pose assumed by various species of birds is in itself a study not devoid of interest either to the naturalist or the physiologist.

It is probable that, as in the case of struthious birds, the gizzard stones are disgorged, but we have no evidence thereof; it would be most interesting to ascertain if such regurgitation takes place, also if any correlation could be traced to seasonal or sexual conditions. The fecund kiwi within a brief period has to furnish a large supply of calcareous material for the formation of the egg shell; amongst gallinaceous birds in some cases the requisite supply of lime may be as considerable in proportion to the size of the bird, but longer time is given for its elimination and deposition; *Gallus*, *Perdix*, or *Coturnix* may be cited as examples, the prolificacy of these genera being evidenced by the production of from twelve to fifteen eggs, but the formation of these spreads over many days. The inquiries which suggest themselves are as follows:—To what extent (if any) do the gizzard stones affect the supply of necessary calcareous material for the wants of the female? Are the fragments of stone in the gizzard of the female greater previously to the breeding season than at other periods of the year? It must not be forgotten that the difficulty of obtaining the lime supply can only be fairly estimated by personal acquaintance with the habitat of the kiwi.

The feather of the *Apteryx* as distinguished from the emu, exhibits the peculiarity of not possessing an accessary plume; the barrel is very short in reference to the shaft and its diameter small. Taxidermists allege that the plumage of the kiwi is loosely attached to the skin and readily drops out, and a reason to account for the ease with which the quill parts from its sac might probably be found in the drying up of certain secretions after death. In dissecting specimens we found that the quills of the feathers over some portions of the trunk were deeply seated in the skin, so much so that we believe the bird would instantly feel the contact of external objects that might touch the spinal and femoral plumage. The thick tough skin which envelopes and protects this night toiler, working amidst the humid mosses of the bush, is rendered more completely defensive by being thus endowed with a keen sense of touch, for by the slightest displacement of its feathers the retiring cautiousness of the bird is at once awakened, and it is enabled to shrink from danger.

Dogs readily follow the scent of the *Apteryx*; those belonging to miners and prospectors destroy great numbers, far more than either they or their owners consume. We have observed that some kiwi-hunting dogs become so dainty that they content themselves with tearing off the head for the sake of consuming the brains, leaving the rest of the carcase untouched. Dogs that have lost their masters and have gradually entered upon a wild life,

are on the increase on some parts of the coast. Several were heard of up the Wanganui river as being in packs, but no attempt had been made to destroy and stamp out this beginning of a serious nuisance to the settler. Bushmen do not dislike the flesh of the kiwi, nor is this fact at all surprising to those acquainted with it, for although the meat is coarse it has a gamey flavour. We found the kiwi made excellent soup and stew, flavoured with pepper and salt, a few leaves of *Drimys*, tender shoots of *Rhipogonum* and *Schefflera digitata*, or piki-piki (the young curled tops of *Asplenium bulbiferum*). The gizzard is especially delicate, very unlike that decidedly tough organ of the domestic fowl. Mr. Docherty reports the eggs to be excellent eating.

This bird, it is said, exists in great abundance in the "Sound country" of the S.W. coast, but we fear that an evil day is at hand for these quaint denizens of the ancient forest; the requisitions of diggers, of collectors for museums, and the cruel slaughter by dogs, they might outlast for years; these causes are rapidly thinning their numbers, but they are not suddenly sweeping the *Apteryx* from the face of the earth. The new source of danger it is said arises from "that deformed thief fashion." A demand is springing up for the skins to furnish material for muffs for frivolous women; although the thought may seem far-fetched, who knows but this female vanity may be the means of modifying the serene climate of the West Coast, by causing the extermination of an ancient race of insect eaters, usefully employed as preservers of the forest. However much on economical grounds we may question the right or policy of permitting the extirpation of so useful a check on insect life, in this colony a strong protest against such barbarity cannot be expected; a few lovers of nature might raise their voices against it, but their words would fall unheeded unless backed by general opinion from without our little sphere. Instead of protest it is more likely that some blatant announcement would be circulated of the establishment of a new local industry. It would not be the first instance of living on destruction which could be euphemistically explained as "subduing the wilderness."

That the race of the *Apterygidæ* is indeed ancient is proved by their being found on islands separated by deep channels from the main land.

Before concluding these remarks on the straight-billed kiwi it should be stated that specimens obtained south of the Waitaroa river, in Westland, present some differences of plumage by which they can readily be distinguished from skins in the Canterbury Museum, which were obtained in the neighbourhood of Hokitika. The birds from the northerly districts have a more flocculent plumage, lighter in tone than those which are found in the country lying under the shadow of Mount Cook.

Specimens are occasionally met with that are here and there marked with white, as on the anterior neck, thigh, etc.

Mr. Docherty, the kiwi hunter, informed the writer that up to the close of last year (1871) he had killed about 2,200 specimens of the kiwi and rowi (*A. oweni* and *A. australis*).

No. 63.—APTERYX MANTELLI, *Bartl.*
Kiwi or *Kiwi-nui.*
Brown Kiwi.
North Island Kiwi.

The North Island kiwi is now a rare bird, seldom to be found even in places where some few years since it was not uncommon. Ornithologists have manifested a disposition to drop this species and refer it to *A. australis*, on what appears to be insufficient grounds. The writer has had opportunities at divers times of becoming acquainted with living examples both of *A. mantelli* and *A. australis*; he has examined several skins of the North Island species, whilst hundreds of skins of the southern bird have passed under his observation, the result is that he arrives at conclusions which are opposed to Dr. Finsch's and also Mr. Buller's views on this question, (See *Trans.* N.Z. Inst., Vol. III., pp. 52–54). Mr. Buller writes thus :—"Mr. Bartlett draws the following distinction as to the colouring of the two supposed species—'*Ap. australis*: Colour, pale greyish brown, darkest on the back. *Ap. mantelli*: Colour, dark rufous brown, darkest on the back.' The above descriptions are applicable, the former to the female and the latter to the male of the common species." In this paragraph Mr. Buller, in a summary way, disposes of Mr. Bartlett's (to our thinking) correct view of the distinction in the colour of the two species, and falls into a grave error by attributing sexual difference of colouration. It may not be impertinent to ask whence have specimens been obtained, or in what collection can authentic examples be seen that display a sexual distinction of colour hitherto unknown to the troglodytal *Apterygidæ*?

That which Mr. Buller terms Mr. Bartlett's strongest point, namely, the distinction to be drawn from the scutellation or reticulation of the tarsus, is left for elucidation in Mr. Buller's work on our birds, now in progress. We have no hesitation in maintaining that the plumage *alone* presents sufficiently marked characteristics for the retention of the two species. In the "Catalogue of the Birds of New Zealand" (p. 23) Captain Hutton in some half-a-dozen words points out the distinction, which cannot be gainsaid, "*A. australis*: Feathers soft to the touch. *A. mantelli*: Feathers harsh to the touch."* The nut is cracked at a blow. The feathers which clothe the southern bird are produced into soft hair-like points ; the hand passed over the plumage against the lay of the feathers encounters an almost downy softness; when compared with a similar test applied to the covering of *A. mantelli* it might be fairly so termed.

* See also *Trans.* N.Z. Inst., IV., 363. —ED.

The reason is obvious, the feathers of the latter species are produced into hair-like points of almost bristly stubbornness. This contrast in the character of the plumage is distinguishable in the young state. In Christchurch, either in the Museum or in private hands, there are specimens from which such a comparison can be made. In the words of a man experienced in mounting the skins of *Apteryx*, "the two species could be separated with one's eyes shut." This peculiarity leads one to expect that there exists some difference in the habit of the species, depending probably on climatic influence or the physical conditions of its habitat.

Dr. Finsch, after careful and repeated examination of two specimens received from Dr. Buller, cannot bring himself to consider the species as distinct, yet admits (which he may safely do) that the harshness of the plumage on the occiput and hind neck of *A. mantelli* may be constant; he gives also a very plain and good reason why it is so, namely, from the structure of the feathers. The conclusion he arrives at is that *A. mantelli* may be a local form of *A. australis.* Now comes our difficulty, in admitting distinct and constant varieties to form what may be termed sub-species in our fauna it may be only reasonable to ask where the line is to be drawn and who is to draw it? What authority is to decide the nice question as to the points which separate the distinct variety from a good species?

In 1852 the late Captain Daniells, of Rangitikei, one of the pioneers of the Wellington settlement, spoke of the brown kiwi as then being procurable from the Maoris. From reliable sources the writer is aware that it is frequently heard in the bush in the neighbourhood of Tauranga.

No. 64.—APTERYX HAASTII, *Potts.*
Roa-roa?
Haast's Kiwi.

Little addition can be made to the previous notes which accompanied the description of *A. haastii* (*Trans.* N.Z. Inst., Vol. IV., p. 204). During a visit to the West Coast last summer the localities were pointed out to the writer whence the specimens now in the Canterbury Museum were procured. One was found in the bush far up the Okarita river, the other in the dense bush between the eastern shore of Lake Mapourika and the snowy range of which Mount Cook is monarch. Mr. Docherty stated that both of these birds appeared wilder than *A. australis,* and made somewhat more resistance during their capture.

Apteryx maxima, Verr., is as yet amongst the desiderata of collectors. Maoris commonly assert that such a bird exists. It is stated to be as large as a turkey. A recent communication from a settler at Martin Bay gives some weight to these statements.

It is probable that other species will be added to this interesting genus; for the past two or three years we have known of the existence of a white kiwi, information concerning it having been scantily furnished at intervals by some wandering miner or prospector. Specimens have at different times been obtained from the bush in the Martin Bay district. From the descriptions that have been gathered they are not albinos, and their occurrence has been too frequent for them to be classed amongst specimens showing a mere accidental and rare variation either of *A. oweni* or *A. australis*; the plumage is stated to be remarkably loose, soft, and flocculent. It is suggested that the name of *A. mollis* would not be inappropriate as its specific designation. A specimen of this beautiful little *Apteryx* in the Dunedin Museum has the bill slightly *curved*, showing an arc elevated about one-fifteenth of its length.

	In.	Lines.
Bill from gape to point	3	9
Tarsus	2	5
Middle toe and claw	2	4

Plumage white, extremities of the feathers more or less stained with yellowish; bristly integument at the base of the mandibles yellowish; narrow yellowish stain round the eye; irides brown; feathers soft to the touch; habitat, bush about Martin Bay, west coast of Otago.

Other specimens have been obtained at Greymouth. The men who seek a living in the wilds of the S.W. coast of the South Island are not given, as a class, to the study of natural history; examples of the rarer species of our fauna are not the specimens they care to hunt for. Not long since the writer met with a man who had probably fed on the *Notornis*, and had lived for two or three weeks on the rare eggs of the crested-penguin. Inquiry made of a boatman at the Waitaroa concerning the eggs of a rare, perhaps unknown, petrel, or *Puffinus*, elicited the information that "not being pretty at all they were hoved away." A similar fate befel some eggs of the white heron, "because they would not go in the billy." *Auri sacra fames*, our noble motto, oft blunts the spirit of inquiry about all other objects. When journeying along the West Coast the writer was informed by a very intelligent Teremakau native that far to the south a black kiwi was to be met with; he described it as "all the same as the kiwi, only black." Probably this may be the bird which the Bruce Bay Maoris call the toko-weka; *Apteryx fusca* would properly distinguish this sombre-plumed species. There seems to be some tendency to dusky colours along the S.W. coast as seen in this kiwi, *Ocydromus*, etc., the black shag, for a long distance at least, according to our observation, frequents such points as are occupied by *P. punctatus* on the eastern side, so also *Hæmatopus unicolor* is there found in far greater abundance than *H. longirostris*.

No. A. 65.—CHARADRIUS OBSCURUS, *Gml.*

Red-breasted Plover.

About the middle of January the red-breasted plover may be found about the coast. We have seen old and young birds together on the flats at the head of Port Cooper on the 19th of January. They migrate from one part of the country to another, from the coast line to the higher grounds for breeding. They appear around Lake Heron in large numbers, finding their way to the Upper Rangitata flats in August. We have before noticed how this plover affects localities of considerable altitude for breeding, and we have a note of the occurrence of the nest and eggs as late as February on Browning Pass.

No. 65.—CHARADRIUS BICINCTUS, *Jard.*

Dotterel.

NOTE.—September 4th, weighed four dotterels.

Nos. 1 and 2	...	...	...	...	$2\frac{3}{4}$oz. each.
„ 3 and 4	...	...	...	...	$2\frac{1}{4}$oz. „

No. B. 65.—ANARHYNCHUS FRONTALIS, *Quoy.*

Crookbill.

Little variance is to be found in the weight of the crookbill. September 4th weighed eight crookbills. Six weighed 2oz. each, two weighed $1\frac{3}{4}$oz. each.

No. 73.—ARDEA ALBA, *Linn.*

Kotuku.

White Crane.

A description of the habits and nesting of this interesting bird was contributed to the *Ibis* last year by the writer.

We have a note of the occurrence of a specimen which has a few black feathers. It is to be hoped that measures may be taken not only to preserve this fine wader from slaughter at all times in the year, but also that its breeding stations may be protected. The destruction of the white heronry on the Waitangituna river would almost exterminate the race over a great extent of country.

Could our noble kotuku enjoy the advantage of foreign birth, like the pert sparrow or black swan, what columns of print would denounce its destroyer before the virtuous indignation of the public would be appeased. We have recently learnt that one grand heronry, far away to the south in this island, has been utterly destroyed.

No specimen appears in the different Museums of the Colony of a variety of the white heron with yellow-stained plumes depending from the head. From a reliable source the writer is aware that a specimen was obtained in the Hakateramea district, South Canterbury. Hearsay evidence has given other

localities where this bird has occurred. This note is made with a view of drawing the attention of such naturalists as may have opportunities of making themselves acquainted with our wading tribes.

No. C. 78.—HIMANTOPUS SPICATUS, n.s.
Black-throated Stilt.

Diagnosis of a female killed in October on the Selwyn or Waikerikeri river.

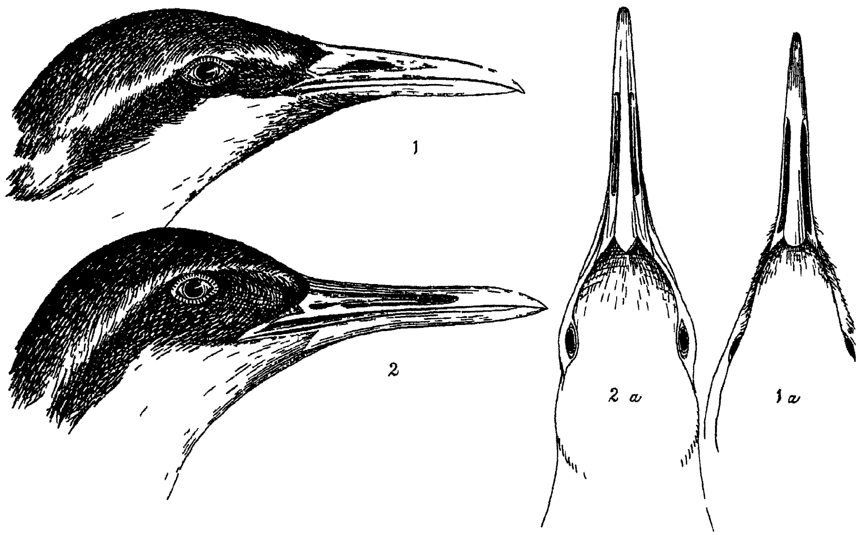
Upper plumage deep blackish green; frontals narrow; irregular circlet round the eye; chin white; space between eye and gape white, slightly flecked with black; *foreneck and part of breast black*; lower part of breast white; feathers sparingly margined with black, deepest on the centre of the breast; *abdomen, white*; tibials white, tipped with black; upper tail-coverts white, slightly tipped with deep green; under tail-coverts white; tail blackish green, four outer feathers on either side having the inner webs marked with white and brown, centre feathers deep blackish green, shafts white; shafts of wings black; bill black; legs light red, deeper colour than those of *H. leucocephalus*, but not so deep as those of *H. melas = H. novæ-zealandiæ*.

	In.	Lines.
Bill from gape	2	9
Tarsus	3	9
Middle toe and claw	1	6½
Wing from flexure	10	2
Tail	3	3
Total length	17	1

On comparing this specimen with a large series of *Himantopus* in the Canterbury Museum the bill was found to be shorter than that either of *H. melas*, or *H. leucocephalus*. The bird was a female, nearly in a condition to lay.

No. A. 79.—LIMNOCINCLUS AUSTRALIS, *Gray*.
Marsh Sandpiper.

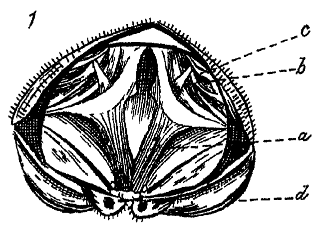
On December 12th four small sandpipers were observed on the shore of Lake Ellesmere; these were obtained for the Canterbury Museum. Male, summer plumage, bill black; irides dark brown; top of the head ferruginous speckled with black; line from immediately above the base of upper mandible through the eye white; throat and chin white; ramals white with a few minute dots of brown, upper surface, centre of feathers dark brown, feathers margined with fulvous shaded down to almost white at the distal end; upper wing-coverts dark brown, edged with fulvous; primaries dark brown, outer web, darkest; shafts white; secondaries brown, narrowly edged with white; upper tail-coverts dark brown, edged with fulvous; tail brown, tipped with

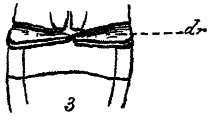


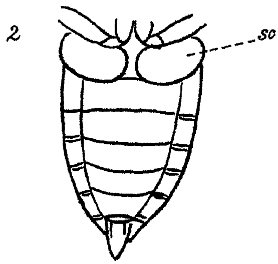
1 1 a RALLUS PECTORALIS Less From type sp in Bullers collection CM
2 2 a RALLUS PICTUS

JB del et lith

Transverse section of the abdomen of the female Cicada, showing the rudimentary drums (*dr*)







1 Transverse section of the abdomen of the male Cicada, showing anterior view of the muscles for vibrating the stridulating membrane (*a*) muscle, (*b*) tendon inserted into (*c*), the under surface of the stridulating membrane, (*d*) the drums.

2. Under view of the abdomen, showing the scales covering the openings into the drum-cavities (*sc*).

3 Ditto, the scales removed, showing the drum-cavities (*dr*)

4. Upper surface of the stridulating membranes (*str*).

fulvous; neck pale fulvous, speckled with brown; breast and abdomen white; under tail-coverts white with a narrow streak of brown in the centre; legs, feet, and toes greenish brown, tinted with yellowish.

	In.	Lines.
Bill from gape to point	1	2
Tarsus	1	2
Middle toe and claw	1	1
Wing	5	2
Total length	8	6

Weight $2\frac{1}{2}$ oz.

Female is of smaller and slighter frame, weighing $2\frac{1}{4}$oz.

This sandpiper, identical with *L. acuminatus*, Gould, is found both in Australia and Tasmania. Specimens have been recently received from Adelaide, South Australia, which were marked as having been procured in Northern Australia.

This is, perhaps, the first notice of the occurrence of this little *Tringa* so far to the south as Canterbury, New Zealand.

No. 84.—RALLUS PICTUS, *Potts.*

Pl. XVIII.

Dr. Finsch does not allow this as a good species.

Sketches are given which will permit a comparison of the bills of *R. pictus* and *R. pectoralis.* As yet the Canterbury Museum has been unable to transmit a specimen to Europe to enable foreign ornithologists to view the difference between these two rails.

For an account of the relative measurement, etc., of the two species see *Trans.* N.Z. Inst., Vol. IV., p. 202.

No. 87.—OCYDROMUS.

On the southern river Waio, Westland, we procured a small woodhen (weka) of rich rufous. The cry of this bird differed from that of the usual *O. australis* in being repeated with far greater rapidity of utterance.

No. 92.—CASARCA VARIEGATA, *Gml.*

Paradise Duck.

We have a note of the occurrence of the nest of this bird at 15 feet from the ground in a hole in a black birch (*Fagus cliffortioides*) near Forest Creek, Upper Rangitata.

No. 95.—SPATULA VARIEGATA, *Gould.*

Shoveller.

A nest with ten eggs was found at Big Bay, Lake Ellesmere. The eggs do not differ from those before described. (See *Trans.* N.Z. Inst., Vol. III., p. 103.)

No. A. 106.—Puffinus tristis, *Forst.*

Mutton-bird.

The young mutton-bird has been obtained from holes in the cliff at Sumner; this downy mass of oil presents the curious fact of being larger than the parent bird.

No. A. 119.—Prion australis, n. s.

Southern Prion.

A short time since amongst some birds which arrived at the Canterbury Museum from Foveaux Strait, transmitted by the Rev. T. Wohlers, were specimens of a *Prion* which, from a careful inspection, could not be referred to either *P. turtur* or *P. vittatus.*

It is said to breed in holes, and descriptions are given below of the adult, young, and egg. In considering this specimen as new it is to be noted that the bill is considerably longer than the head; it is also much broader than that of *P. vittatus,* according to Gould. The pectinated apparatus of the upper mandible is fully disclosed. Of the primaries the first is quite as long, if not longer than the second quill, whilst the total length exceeds that of *P. vittatus* by some inches. It breeds on Papatea, or Green Island, near Ruapuke, in Foveaux Strait.

Adult.—Head dark bluish grey, mottled sparingly with black; aurals slatish, bounded above and below irregularly with white or yellowish white; upper surface bluish grey; scapulars clouded with slaty black, tail-coverts tipped with the same; under surface white; under tail-coverts white, just tinged with delicate ash grey; quill feathers, of which the two first are longest and of about equal length, outer web black, inner web white, more or less stained with ash grey; tail bluish grey tipped with black; chin naked, the skin marked with narrow angular furrows arranged in regular order, angle within angle; bill longer than the head.

	In.	Lines.
Bill from gape to point	1	9
Greatest width	0	11
Tarsus	1	5
Middle toe with claw	1	6
Wing from flexure	8	0
Tail	4	0
Total length	14	3

The young taken out of the nest by Mr. Wohlers on the 25th November are clothed entirely with a dense covering of dark smoky grey, lightest on the neck and under surface, pectinations of the upper mandible undeveloped; the bill measures from gape to point 1 inch, greatest width only 4 lines. The

egg, which gives out a rancid sub-musky odour, is white, oval in form, measures 2 in. 6 lines through the axis, with a breadth of 1 in. 6 lines.

No. B. 131.—STERNA NEREIS, *Gould.*
Little Tern.

We have eggs of this tern from the shore of Lake Ellesmere.

No. 138.—PHALACROCORAX PUNCTATUS, *Sparrm.*
Kawau.
Spotted Shag, Ocean Shag,
Crested Shag, or Flip-flap.

The spotted shag, or flip-flap, well known to our shore folk, is stated by ornithologists to be peculiar to New Zealand; its active movements enliven many a bluff headland or rocky inlet of our island coast line. It derives the name of the spotted shag from the grey feathers of its upper surface terminating in a dark green spot; some persons term it the ocean shag from its marine habits; it is known as the crested shag from the supplementary head feathers assumed in the winter and early spring months; it is called the flip-flap from its habits when cruising up the harbours following shoals of fish.

As gregarious as some of its congeners it may be seen flying, swimming, fishing, or nesting, in large companies; these numbers that thus delight to live together do so peacefully, with an absence of much of the clamour and bickering that often marks the state of living where multitudes congregate. With these assemblies life passes in alternate periods of restless activity and restorative repose; birds fly from one favourite fishing ground to another, usually at a low elevation, keeping just above the curl of the wave; in these short trips the flight seems more direct, and the aim more decided, as to the point to be reached than in the case of its congener *P. carbo.* If disturbed, as by a boat, it often, after taking wing, makes a circuit; sometimes this tour is repeated twice or thrice, never at a great height; this habit is so much a matter of course that we have often observed people calling out, "come back, come back," under the notion that the flip-flap will sail round once more. At the fishing ground its wonderful powers of diving insure an ample food supply, and its take of fish must be astonishingly great, as a half-pound moki is soon ingulfed in its capacious throat. Not content with exploring the deeps that wash the coast it follows shoals of fish up the smoother waters of the harbours; in calm autumn days often have we watched the still waters of our shallow bays flash with the swift motions of the flip-flap. Sometimes a solitary fisher may be noticed cruising about; when diving no particular course appears to be taken, but only the fish pursued, as one may guess from noting the places where the bird reappears after diving. When the shag's wants are supplied, and its voracity appears almost insatiable, it seeks the rocky shore or cliff, and

basks on the sunlit crags till its rapid digestion relieves it from temporary repletion, and it is once more ready for sea; when on the rocks it may be noticed drying its plumage with outstretched wings just in the same manner as does *P. carbo.* This shag swims low in the water, the tail is kept about level with the surface, and appears to afford great help to the bird when it essays to rise on the wing from the water; this feat is accomplished by a slow ungraceful action, three or four leaps or bounds being necessary with the body held partly upright before it is fairly launched in flight. When perched the tail affords help in maintaining the almost perpendicular attitude the bird then assumes, and it keeps its equilibrium on the steepest cliffs as firmly as if supported by a self-adjusting tripod. The site of a nesting place is often in some sheltered nook in the cliffs, where, perhaps, whole rows of their structures may be observed in close neighbourhood and frequently the position chosen is almost, if not entirely, inaccessible. Both males and females labour in building their homes, which are often constructed of *Algæ*, placed on a foundation of sticks. We have seen the birds carrying quite a large bunch of material at a time, so large and cumbersome the load that they have now and then been unable to effect a landing at the first attempt; a wide circuit has enabled them to place their burthen on the spot where the nest was to be raised.

As in the case of birds in many other and far removed genera, the constructive faculty appears most developed in the female; we have often noticed her sitting on the nest carefully and deftly arranging the tufts of material brought by her mate, some portion of which is collected from a great distance. We once saw, in a strong N.E. breeze, a fine bird beating out of Port Cooper, with a large piece of stick carried fore and aft. When the nest is completed it may be about 5 in. high and about 14 in. across; it soon becomes foul and loathsome (a mass of writhing maggots), with a most horrible stench. Three eggs are laid, measuring in length 2 in. 4 lines, in width 1 in. 6 lines, of greenish white, more or less clouded with chalky white. In a brief space they become mottled and stained to an extent that quite alters their character; these marks are no doubt occasioned by the incubating bird sometimes feeding at home, as bloody smears on the eggs are not otherwise to be accounted for unless thus painted by the fresh fish-blood on the bird's mandibles when the eggs are duly turned in the nest. The labour of incubation is fairly shared by each sex, as we have noticed that when one bird has left its charge its mate has immediately supplied its place; when alarmed on her nest the shag utters a low note, rapidly opening and closing the mandibles, which gives a peculiar throbbing appearance to the cheek. From the middle of October the breeding season extends through the earlier summer months.

The embryo is at first flesh-coloured, and gradually assumes a darker hue on its upper surface till it reaches a dull slate colour; the mandibles light horn-

colour, darkest at the extremeties, gulal pouch well developed. The young, blind when hatched, is of a lead colour, darkish about the eyes and along the centre of the back; mandibles and gulal pouch flesh colour; tips of mandibles pinkish; tarsi lighter than the rest of the body; tongue very small; pectinated apparatus of the middle claw undeveloped; the entire body naked, being utterly devoid of down or feather. The first indication of plumage is the sprouting of the hair-like down of the tail, dark brown down next appears on the upper surface, whilst the under parts are covered with whitish down; the condition of the young always appears most thriving, the abdomen is distended as though stuffed. In the next change in the appearance of the young we note that it has assumed a dull smoky colour, lightest on the abdomen, the chin, and tarsi, the latter lightest on the inside; another change occurs before quitting the nest, the whole upper surface becoming of a dull slaty brown, almost white beneath; lore, chin, and pouch purplish flesh; up to this stage the aural orifice is unprotected. When clothed with down the middle claw is still wanting in its pectinated apparatus.

Whilst in the nests the young stretch up their long necks and move their heads in a snake-like manner from side to side; their note is hoarse and brief like the woffling bark of a puppy; when of a size to fill up their home the old birds remain at the edge of the nest. Below the nests there may often be observed a substance that looks not unlike some species of coral, this is formed of the exuviæ of these birds, and by the solidifying of the liquid ejections which the shag so constantly produces. A well-known sea mark near Banks Peninsula, known as "White-wash Head," owes its distinctive name to the colour it has assumed from the accumulated white droppings of this sea fowl. It leaves its nest with reluctance as it is not a shy bird. The position chosen for the nest is perhaps rather to secure the advantage of shelter than from the fear of depredators. Its gruff brief note is not often heard; when ashore we have noticed that it frequently opens its mandibles widely as though the trachea was irritated by the presence of some parasite.

Ticks sometimes are found firmly fixed on the throat. It is worth noting that the plumage of the young when they leave the nest is of a dull inconspicuous tint, which may be of great advantage, not only in obtaining its food, by securing a nearer approach to its prey without observation, but also by its tone affording a certain amount of protection, as either afloat or ashore its colour harmonises with its surroundings, so that it is far from being a striking object; young females up to the period of their first nest differ but little from the tints of the young state. In this state of plumage these birds most frequently visit the shallower waters of the bays in the harbours; at sea we have never met with shags far from land, hence the name of ocean shag

does not seem appropriate. It will be observed that the middle or cleansing claw has a slight twist, and the comb differs from that on the middle claw of *Ardea* in the case of the bird under notice; the comb really appears to be an addition carried out to the end of the claw, and is doubtless an useful and well-used instrument; it is flexible to a certain degree, and it would be more proper to describe it as a scraping instrument than a comb; in fact it is the inside edge of the middle claw produced into a scraper of about sixteen broad curved flexible teeth.

As far as we know the spotted shag dives from the surface of the water, not from the heights from which some of the anserine order dash on their prey, yet those who examine its structure will note how admirably its anatomy is calculated to resist the strain or pressure caused by its manner of obtaining food, the coracoid and adjacent bones being not only in themselves of great strength, but also firmly attached to the sternum. The eye subject to so much exposure is defended in addition to the armature of the lore by a circlet of round flexible plates. In life at certain seasons these are of deep turquoise blue, and add greatly to the appearance of this bird.

Perhaps no other species of our *Pelecanidæ* is sooner or more completely robbed by death of so much of its beauty and character as *P. punctatus*, the evanescent colours of the membranes that decorate as well as protect certain parts of its body, and the varying tints of yellow, green, blue, and purple, defy the skill of the taxidermist to preserve and fade away into the semblance of a mass of leathery wrinkles.

The changes that take place in the plumage and in the colouration of the membranous processes have led some persons to make two species of the spotted shag, but a careful study of a large series of specimens procured at various periods of the year, and a tolerably close observation of the bird in its favourite haunts, prevents the writer from coinciding in this view. Having described the young from the embryo through several of its changes of appearance till it is of a size almost to quit the nest we now give some notes of its state of plumage at different ages and seasons.

Young female killed in March. Upper surface dull smoky grey, the apex of the scapulars of dull greenish brown; outer wing-coverts dull brown, edged with pale fawn; under surface white; thighs dull brown; tail-coverts dark brown; tail dark brown, shafts white; lore and chin yellowish flesh, tarsi and feet dull flesh colour. Female killed in August—Upper surface dark smoky brown, with a greenish glint on the head and neck, scapulars terminating in a deep green spot; back dark brown, changing to dark green; under surface white; throat and anterior of neck pale ash, leaving a broad stripe of white from the base of the upper mandible below the eye as far as the wing; lore and chin (of fine texture) dull, rather yellowish flesh colour; tarsi and feet

dull flesh colour. Males of the same age present no observable contrast in their plumage to that of the other sex. When this shag is about a year old the membranous processes, which are such conspicuous features, gradually lose their former texture, and become coarsely granulated; dark green spots are sparingly dotted on the wing-coverts, the throat assumes a darker hue, the white shafts of the tail feathers are exchanged for rectrices with shafts of slaty black, the two centre feathers are the first to be replaced; tarsi and feet take a more decided tinge of yellow. In all these changes there is a remarkable want of constancy, so that to note down all the variations that may be observed in an extensive series would exceed all reasonable limits for such a paper as this.

In the nuptial plumage this common bird becomes one of the handsomest of our sea-fowl, the great and striking alteration conferred by snow-white accessary plumes that decorate the head lasts but a short time in perfection in either sex, and gradually moults away into the more sober garb of the summer plumage. In the month of August adult birds have the head greenish brown, sparingly interspersed with narrow white feathers, immediately above the forehead rises a tuft of dark brownish green feathers, while another of the same shade forms a long irregular crest just above the nape; this inclines forward, reminding one of a clown's *toupet*; on either side a line of snow-white feathers, more or less produced, extends from above the eye to the wing, meeting in a broad band below the nape; upper surface brownish grey, marked with deep green spots; back deep glossy black-green; throat blackish green; under surface, leaden grey; lower abdomen, tail, and thighs deep glossy black green; thighs often sprinkled with narrow white plumes, which, like those on the head and neck, are of temporary duration; mandibles, horn colour; lore, bluish purple, the eye circlet of torquoise blue; chin greenish, often bluish purple, deepest at the point; tarsi and feet yellow.

Summer plumage, November: Head, neck, and upper surface dark greenish grey; wing-coverts and scapulars, dotted with deep green spots; throat and neck pale grey, mottled with dull green; under surface leaden grey; lower abdomen black green; rectrices black.

MEASUREMENTS.

	In.	Lines.
Bill from gape to point	3	4
Tarsus	2	5
Wing	9	2
Length	28	

Average weight of adult birds may be fairly estimated at 2 lbs. 13 ozs.

When this bird is cruising in search of prey its long neck is often moved from side to side, reminding one of the habits of the nearly allied *Plotinæ*; this is observable too in the young nestlings; of some species of *Plotinæ* it is said that the neck is always in oscillation.

Art. XXI.—*Remarks on some Birds of New Zealand.*

By Otto Finsch, Ph.D. of Bremen, Hon. Mem. N.Z. Inst.

[*Read before the Philosophical Institute of Canterbury, 5th June,* 1872.]

Through the kindness of my friend Dr. Julius Haast, I had the pleasure to receive a collection of bird-skins, which, in connection with some others kindly sent me for comparison by Capt. Hutton and Dr. Buller, enabled me to proceed with my studies of the New Zealand avifauna, and to become better acquainted with a number of its species. In accordance with these investigations I have prepared an article which will shortly appear in the "Journal fur Ornithologie," under the title "Revision of the Birds of New Zealand."

I intend to report in that paper, not only on my own researches but also on the useful labours of my antipodean ornithological brethren, in order to make known to our German colleagues the interesting reports given by Dr. Buller, Capt. Hutton, Mr. Potts and Mr. Travers. The excellent accounts on habits and breeding as published by Mr. Potts will especially be thankfully received, and I regret that I was only able to give extracts from his very interesting papers.

My paper will also contain a new revised enumeration of all New Zealand birds, after a new systematical arrangement which proved to be necessary.

The total number of species amounts to 149, but amongst them are still some which on further investigation will lose their specific rank.

I thought it would be of interest to my ornithological friends in New Zealand to offer them the most important facts of my researches before publishing them in the German Journal, but I beg to apologize for their shortness and imperfection, and therefore must refer them to my forthcoming extensive paper.

Falco novæ-zealandiæ, Gml.

After a careful examination of specimens of both sexes from the South and North Islands, I see no reason for a specific separation of *F. brunneus*, G. Mr. Gurney (*Ibis*, 1870, p. 535) is inclined to believe that there exist two species, differing only in size, but his larger form (*novæ-zealandiæ*) surely refers only to the large females.

Full accounts and descriptions of this species will be found in my paper.

Circus assimilis, Jard.

I should like to see an old specimen in order to prove whether this species in New Zealand ever assumes the dress of the old Australian bird.

Platycercus novæ-zealandiæ, Sparrm.

My *Pl. forsteri*, based upon Forster's authority, must become united with this species.

Nestor esslingii.

This will prove to be only a variety of *N. meridionalis.* When I wrote my monograph on the Parrots, I had to admit it as a good species because there was a notice by Dr. Haast, stating he had seen the bird himself during his stay on the Alps; he mistaking the alpine form of *N. meridionalis* for the above variety.

Nestor occidentalis, Bull.

This can scarcely stand longer as a species, and is after my examinations inseparable from *N. meridionalis.* The diagnosis given by Capt. Hutton "cere very small" ("Cat. Birds N.Z." p. 20) is of no specific value.

Halcyon vagans, Less.

Having examined a large series of this kingfisher I consider it as a good species, distinguished from *sanctus*, Vig., by the constant broader bill. The colours are generally darker, but certain specimens are difficult to distinguish from *sanctus.*

MEASUREMENTS IN INCHES.

			H. vagans.	*H. sanctus.*
Frontal length of Bill	...	...	·65 to ·71	·53 to ·69
Rictal " "	...	...	·87 " ·98	·79 " ·91
Breadth of bill below	...	...	·23 " ·26	·19 " ·21

Certhiparus novæ-zealandiæ, Gml.

I agree, after examination of specimens from both islands, with Capt. Hutton, in uniting *C. maculicaudus* with this species, but the figure in the "Voy. l'Astrol.," t. 11., f.3, as well as the description, are by no means accurate enough.

Sphenœacus fulvus, Gray.

After my suggestions *Sph. rufescens*, Bull. will probably turn out to be this species. Mr. Gray does not notice a proper locality, so it might be that his bird came also from the Chatham Islands.

Petroica longipes, Garn., and *P. albifrons*, Gml.

These birds seem to be scarcely distinct. They are by no means true *Petroicæ*, but form a singular genus, *Myioscopus*, Reich., distinguished by its long legs, the shorter wings and the stouter bill. *Myioscopus* belongs to the *Luscininæ*, and is nearest to *Erythacus.*

Anthus grayi, Bp. (Hutton, "Cat. Birds N.Z.," p. 13).

This is based on Forster's "*Alauda*, No. 96" (*Descr. anim.*, p. 91), and has no right to stand as a species. Most probably Forster described only a darker coloured specimen of *A. novæ-zealandiæ*.

Petroica macrocephala, Gml., and *P. toitoi*, Less.

These are Muscicapine birds, and form the well-marked genus *Myiomoira*, Reich. *P. dieffenbachii* cannot be separated from *P. macrocephala.* I examined specimens from both Islands.

Rhipidura fuliginosa, Sparrm., = *Rh. tristis*, Hombr. and Jacq.

All the specimens I have seen showed not the slightest sign of a white spot above the eye. So I hesitate to unite *Rh. melanura*, Gray, as Capt. Hutton has done, although I am not convinced of the validity of the latter.

Keropia tanagra, Schleg.

There can be not the slightest doubt about the identity of *K. hectori*, Bull. with this species, as Prof. Schlegel kindly compared one of Dr. Buller's types with his type in the Leyden Museum.

Glaucopis wilsoni, Bp.

Gl. olivascens will prove to be this species, as noticed by Capt. Hutton, but it must be based upon an extremely large female, as the measurements given by Von Pelzeln are much larger than any yet recorded.

Aplonis obscurus, Du Bus.

This can not be admitted as a New Zealand bird; there is no evidence of its occurrence in New Zealand.

Creadion carunculatus, Gml.

It is somewhat satisfactory that the examination of the types by Capt. Hutton has shown *Cr. cinereus*, Bull. to be undoubtedly the young of the above-named species, as I suggested long since ("Journ. f. Orn.," 1867, p. 343).

Prof. Giebel, in his new "Thesaurus Ornithologiæ," puts this characteristic form as a synonym of *Anthochæra inauris*, Gould! I think ornithologists will not be very satisfied with this arrangement.

Ardea egretta, Gml.—*A. alba*, Finsch, "Journ. f. Orn.," 1870, p. 345.

I received specimens from both Islands, which are inseparable from *A. egretta*, the American form of our *A. alba*, which differs from the latter only in having the legs and feet black. The New Zealand specimens are indistinguishable from Mexican and Chilian specimens in the Bremen collection.

Ardea sacra, Gml.

A specimen from New Zealand agrees with others from Australia, the Pelew and other Pacific Islands.

Himantopus novæ-zealandiæ, Gould.

This is the unicolour black one, and the same as *H. melas*, Homb. and Jacq. The pied stilt, therefore, named *H. novæ-zealandiæ* by Capt. Hutton, ("Cat. Birds N.Z.," p. 29), will be nothing as a state of the black species, whereas *H. novæ-zealandiæ*, Potts (*Trans.* N.Z. Inst., Vol. II., p. 70), is probably *H. leucocephalus*, Gould.

Tringa canutus, Hutton ("Cat. Birds N.Z.," p. 30).

This, I expect, will turn out to be *Tr. crassirostris*, Temm. and Schleg. (Faun. jap. pl. 64), the larger eastern representative of *canutus*.

Ocydromus troglodytes, Gml.; *O. australis*, Finsch, "Journ. f. Orn." 1870, p. 352.

This species has been hitherto confused with *australis*, Sparrm. I shall treat of all the New Zealand *Ocydromi* (four species) extensively in my paper, with full descriptions and their corrected synonymy. *O. troglodytes* is the largest, and easily recognizable by its olive brownish-yellow colouration, and is the bird figured by Gray ("Ereb. and Terr." t. 14).

Ocydromus australis, Sparrm.

Considerably smaller, and of an olive, rufescent-brown, ground colour; tail feathers barred regularly with black and rufous brown.

I received one specimen from Dr. Haast.

Ocydromus fuscus, Du Bus.

I examined one of the types of *O. nigricans*, Bull. There can be no doubt of its identity, as I declared already.

Rallus pectoralis, Less.

Specimens from the Okarita Lagoon, sent by Dr. Haast, agree perfectly with others from Australia, the Pelew and Samoa Islands.

Mr. Potts' new *R. pictus* (*Ibis*, 1872, p. 36) based upon a specimen from the same locality, has no claim as a species.

Lestris parasitica, Hutton ("Cat. Birds N.Z.," p. 40)

Is apparently not this species, but *L. longicaudatus*, Briss. (Buffoni, Boie —*spinicauda*, Hardy *nec* Layard.)

Larus novæ-hollandiæ, Steph. (*L. scopulinus*, Finsch, Hutton, Potts.)

I shall describe all the plumages of this very confused species and settle the synonymy.

The larger *L. jamesoni*, Gould, is not yet separated exactly, although there exists a great variety in size, especially in the bill.

Larus pomare, Bruch. "Journ. f. Orn.," 1855, p. 285, *nec* 1855, p. 103.

To this species belong *L. melanorhynchus*, Bull.; *L. bulleri et jamesoni*,

Hutton ("Cat. Birds N.Z.," p. 41); and *L. bulleri*, Potts (*Ibis*, 1872, p. 38); as I can state positively, having type specimens of all these so-called species, and besides the types of Bruch from the Museum at Mayence.

The *colouration* of the bill varies (after season and age) from black to reddish-yellow with black tip (this latter form represents *L. bulleri*, Potts), that of the feet from black to reddish. I have seen intermediate specimens. This species is characterized by its slender bill, and chiefly by the white on the inner web of the four first remiges, which are white shafted. The extent of this white on the remiges varies after age, as is also the case in our *L. ridibundus* and *L. lambruschius*, which show also a similar variation in respect to the colouration of bill and legs.

I shall treat this species also *in extenso*, and make it thoroughly known.

Sterna—(?) n. sp. Potts, *Trans*. N.Z. Inst., II., p. 77.

This is certainly *St. nereis*, Gould.

Hydrochelidon leucoptera, Hutton, ("Cat. Birds N.Z.," p. 43.)

I suggest that this species has been confounded with *H. hybrida*, Pall. (*fluviatilis*), at least I come to this conclusion in comparing the measurements given by Capt. Hutton.

PROCELLARIDÆ.

The species of this family are, with certain exceptions, far from being well known. I should like to examine specimens of this group, having seen from New Zealand only a single specimen of *Prion ariel*.

Puffinus gavius, Forster.

I think Capt. Hutton is quite right to refer his *P. assimilis* and *opisthomelas* to this since Forster almost unknown species.

P. opisthomelas, Coues, is, according to my views, not so positively to be united with *gavia* as Capt. Hutton thinks; at least a comparison with the types would be the only way to settle the question.

Puffinus tristis, Forst.

Layard's "Mutton Bird" from New Zealand, named by him *P. brevicaudatus* (*Ibis*, 1863, p. 245), belongs apparently to this species.

I am not as sure as Capt. Hutton whether *P.* (*Nectris*) *amaurosoma*, Coues, is indeed identical, and I should hesitate to declare this with certainty until I had compared specimens.

Prion ariel, Gould.

The differences between this species and *Pr. turtur* are indeed very minute, and the identity of both seems very possible to me. I should like to see series of these allied species in order to be clear about their specific value.

Dysporus serrator, Banks.

This species is by no means identical with *D. capensis*, Licht., as Capt. Hutton is inclined to believe, but is a well distinguished species.

D. capensis is easy to recognize in having all the tail feathers black and in having the naked gular space extended in a narrow line to about the middle of the neck in front.

Graculus carbo, L.

Specimens from New Zealand, received through Captain Hutton, are exactly the same as those from Europe, China, Japan, etc.

Graculus brevirostris, Gould.

Whether this species is really different from *Gr. melanoleucus*, Vieill., I doubt very much, after having seen more specimens in a different state of plumage. One specimen is throughout black, another has chin and throat white, and in a third the whole under surface to the flank is white, differing in no way from specimens in the characteristic plumage of *melanoleucus*.

The young of this latter species are black on the under parts.

Eudyptes pachyrhynchus, Gray.

In examining two species from New Zealand I find that the characteristics pointed out for this species by Mr. Gray are not constant. A comparison with *E. chrysocome*, Forst., seems necessary.

Eudyptes chrysolophus, Brandt.

Prof. Schlegel enumerates s. n. *Spheniscus diadematus*, Gould, a specimen in the Leyden Museum ("Mus. P.B. Urinat," p. 8), which certainly belongs to this species. This specimen is labelled as coming from New Zealand, but without the name of the collector.

Eudyptula minor, Forster.

I see no reason to distinguish *Eu. undina*, Gould, specifically after having carefully compared more specimens.

Apteryx australis, Shaw.

Through the kindness of Dr. Buller I received two specimens of the *Apteryx* of the North Island for comparison, which after careful and repeated examination I cannot consider as distinct species. In respect to the colours I have specimens from the South Island before me which are as dark as those from the North Island. The plumage of the latter is harsher to the touch, but in a series there are also different degrees observable. The only difference which I can notice, and which perhaps may be constant, consists in the structure of the feathers which cover the occiput and hind neck. These, in the North Island bird, have longer and harsher black shafts, whereas in the

South Island bird they are shorter and softer. As I do not consider this slight difference important enough I can regard the kiwi of the North Island only as a race or local form,—*A. australis* var. *mantelli*, Bartl.

I shall give an extensive treatise of the known species of *Apteryx* in my revised list of the birds of New Zealand.

Apteryx haastii, Potts.

Judging from the communications on this species sent me by Dr. Haast and Capt. Hutton I take it for a good species. I cannot agree with Mr. Potts as to a hybridism between *A. australis* and *oweni*, because I am sure a hybrid of those species would stand in size intermediate between the two, as is the case in our *Tetrao medius*.

Mr. Potts' name ought to be preserved for this species, for from *A. maxima*, Verr., there exists no other source than the simple name, noticed first by Bonaparte, without any reference to the Roa-roa.

The following species are in my opinion worthy no longer to stand amongst the list of the birds of New Zealand :—

Strix parvissima, *Ellm.*, *Potts*, *Trans.* N.Z. Inst., III., p. 68.

Halcyon cinnamonimus, *Sws.*

Anthochæra carunculata, *Lath.* (Mimus carunculatus, *Bull.*)

Anthus grayi, *Bp.*, Hutton's Cat., p. 13.

Rhipidura motacilloides, *Vig.*, Hutton's Cat., p. 14.

Aplonis obscurus, *Du Bus.*—caledonicus, *Hutt.*

Crex pratensis.—(Rallus featherstoni, *Bull.*)

Anous stolidus, *L.*

Procellaria æquinoctialis, *L.*

Puffinus brevicaudatus, *Br.*

Dysporus piscator, *L.*

Graculus carunculatus, *Gml.*

Aptenodytes pennantii, *Gray.*

Art. XXII.—*On the Birds of the Chatham Islands, by* H. H. Travers, *with Introductory Remarks on the Avi-fauna and Flora of the Islands in their relation to those of New Zealand.* By W. T. L. Travers, F.L.S.

[*Read before the Wellington Philosophical Society, 11th September,* 1872.]

I have compiled, from memoranda furnished to me by my son, Mr. H. H. Travers, and have written in his name, the following notes of the distribution and habits of the birds known to belong to the Chatham Islands, specimens of the major part of which he obtained during a recent visit to that group. The total number of birds mentioned in Capt Hutton's "Catalogue

of the Birds of New Zealand" as belonging to the Chatham Islands is 47, but my son has now reason for believing that the weka (*Ocydromus australis*), the kakapo (*Stringops habroptilus*), and the kiwi (*Apteryx australis*), which were all inserted in the catalogue in question on the authority of a former notice of the fauna of the Islands, published in the fourth volume of the Linnæan Society's Journal—Botany—were erroneously assigned to them. Of the total number in the catalogue which have now been ascertained to belong to the Islands, my son obtained specimens of thirty-eight species, but was unable to procure species of *Ardea sacra*, *Ardea poiciloptera*, *Limosa uropygialis*, *Rallus dieffenbachii*, and *Anas chlorotis*, whilst the memoranda are silent as to others which he did obtain, and notably as to *Diomedea exulans*, *Thalassidroma nereis*, and *Haladroma berardii*.

He obtained two species entirely new to science, which have been named by Capt. Hutton *Petroica traversii* and *Rallus modestus*, whilst, besides these, he has added five other species to the avi-fauna of the Chatham Islands, namely, *Chrysococcyx plagosus*, *Haladroma berardii*, *Graculus africanus*, *Eudyptes pachyrhynchus*, and *Eudyptula minor*, of which the three former were not even previously known to the avi-fauna of New Zealand.

I need hardly say that the Chatham Islands are situated about 450 miles to the eastward of New Zealand, in lat. 42° South, and consist of one large island called Chatham Island, seventy miles long, and which is almost in the shape of an isosceles triangle, the north-western side, about thirty miles in length, forming the base,—of Pitt Island, which is about ten miles in circumference, and of several small rocky islets, of which the principal are named Mangare and South-east Island. The surface of the main land is undulating, and generally covered with grass, whilst all round it is a fringe of bush, more or less broad, containing a considerable number of small trees. Upon this island there are several lagoons, the largest of which is twenty miles in length, by from three to eight in breadth, the waters of which are separated from the sea by a sand beach from half-a-mile to a mile wide. The surface of Pitt Island is completely covered with bush of the same class as that on the main island. South-east Island contains the highest land in the group. Mangare is very small, and the surface stony, but nearly covered with low rigid scrub. Owing to the constant swell from the south-eastward it is extremely difficult to land on these smaller islets, as the sea rises and falls many feet with each wave, rendering it dangerous for boats to approach too closely; indeed, it is only by patiently watching an opportunity that a landing can be effected, and re-embarkation is equally difficult and dangerous, whilst the treacherous nature of the weather increases both the danger and the difficulty. It will be seen, in the course of these notes, that my son succeeded in obtaining a considerable number of birds from these smaller islands, where

they have no doubt been preserved from destruction by the very inaccessibility of their habitats, both to man and to other animals. It is interesting to observe that, except the two new species added to science, nearly the whole of the birds occupying these islands are identical with New Zealand species. It is not at all improbable that *Haladroma berardii* and *Graculus africanus* will also be found on our coasts, leaving only *Petroica traversii*, *Rallus modestus*, *Chrysococcyx plagosus*, and *Anthornis melanocephala* as absolutely peculiar to the Chathams. Of these again *Petroica traversii* possesses exactly the habits, and even the common note, of *Petroica albifrons* and *P. longipes*, whilst *Anthornis melanocephala* is too closely allied to *Anthornis melanura* to render their common descent at all doubtful. The differences between the *Petroicæ* are not so great as those between the two species of New Zealand *Orthonix*, one of which only inhabits each of the two larger islands of New Zealand. This almost identity of the avi-fauna of the Chatham Islands with that of New Zealand is observable also in the flora, of which my son, during his late visit, made almost exhaustive collections. These are now in the hands of Baron von Mueller, of Melbourne, for examination. I am led to believe that the identity which was found to exist between the great majority of the species obtained by him in 1867 and species inhabiting New Zealand, is maintained in connection with the much larger number of species which he collected during his recent visit, but upon this point I have no doubt Baron von Mueller will fully remark when he publishes the results of his investigations.

I have had no opportunity of ascertaining how far this resemblance extends in the case of the other forms of life found in the Chathams, but I think it extremely probable that the greater number of the few insects, etc., which my son obtained will be found to be identical with species also occupying New Zealand. This almost identity of the organic productions of the two groups suggests forcibly a former, and (speaking geologically as regards time) not long past, connection between them, or, in other words, extension of the lower lands of New Zealand so as to embrace the Chatham Islands since the great mass of the existing living productions of both have assumed their present forms. Interesting fields of speculation are opened out as to whether it is the Chatham Island or the New Zealand species now presenting differences of a specific nature which have undergone variation; as for instance in the case of the birds, the two species of *Anthornis*, and in the case of the ferns, the two different forms of *Lomaria discolor*; but I must leave more speculative and more competent minds to deal with this question. I may add that my son made diligent search and inquiry for moa bones, but did not obtain any, nor any information respecting them.

In the following notes, which are to be assumed to have been written by

my son, the numbers opposite the species thus distinguished have reference to those in Captain Hutton's Catalogue.

2. *Circus assimilis.*

This bird is rare in the islands, and I was unable to obtain any specimens for skinning. I found one which had been dead for some days, but which so far as I could judge from the then condition of the plumage, etc., was identical with the New Zealand bird.

11. *Prosthemadera novæ-zealandiæ.*

I found this bird on the Main and on Pitt Island, where it is not uncommon, but I saw no specimen on Mangare. I could detect no differences between it and the birds found in New Zealand.

12. *Anthornis melanocephala.*

This bird occurred in the greatest numbers on Mangare, though I also found it frequently on the main island, but more rarely on Pitt Island. Its note is much richer and fuller than that of its New Zealand congener. It begins to breed in October, the nest being composed of grass and feathers, large and coarsely constructed. As a rule the female lays three eggs. The egg has a brownish pink tinge, and is spotted with a darker colour.

Length, 1·05 in. ; diameter, ·75 in.

14. *Zosterops lateralis.*

This bird has become very numerous, and is especially destructive to the smaller fruits. During severe winters large numbers are said to die from cold and hunger. During my stay at Pitt Island many were found drowned in the pig tub, and I observed in New Zealand that these birds frequent the pits in which house refuse is thrown in search of food. They appear to be carnivorous. They are said to have first appeared in the Chatham Islands after the great fire in Australia on Black Thursday.

21. *Sphenœacus rufescens.*

I only found this bird on Mangare, where it is not uncommon. Its peculiar habit of hopping rapidly from one point of concealment to another renders it difficult to secure. It has a peculiar whistle, very like that which a man would use in order to attract the attention of another at some distance, and although I knew that I was alone on the island, I frequently stopped mechanically on hearing the note of this bird, under the momentary impression that some other person was whistling to me. It also uses the same cry as *Sphenœacus punctatus.* It is solitary in its habits and appears to live exclusively on insects.

26. *Gerygone albofrontata.*

Not common, but found in all the islands. It has very much the habits of the New Zealand species.

29. *Petroica dieffenbachii.*

Not common, but found in all the islands, but I doubt the propriety of separating this bird from *Petroica macrocephala.*

—. *Petroica traversii*, sp. n., Hutton.

I only found this bird at Mangare, where it is not uncommon. It is very fearless, possessing in other respects the habits of *Petroica albifrons* and *P. longipes.* Its ordinary note is also the same, but I did not hear it sing. It appears to be specially obnoxious to *Anthornis melanocephala*, which always attacks it most savagely when they meet. There is no apparent difference in the plumage of the sexes.

33. *Anthus novæ-zealandiæ.*

38. *Rhipidura flabellifera.*

48. *Platycercus novæ-zealandiæ.*

These birds are not uncommon in all the islands, and exhibit precisely the same habits as in New Zealand.

49. *Platycercus auriceps.*

I never found this bird on the main island, but it is numerous on the other islands. I was often for some time surprised at finding the bodies of dead birds which I had thrown away partially eaten, and could not account for the fact until I found this bird feeding on them. This is also a habit of *Nestor meridionalis.* In other respects the habits of this bird are the same as in New Zealand. I obtained a specimen on Mangare, with a faint yellow tinge on the head.

—. *Chrysococcyx plagosus.*

This bird is nearly, if not absolutely, identical with the Australian species. It appears on the islands in the month of September, and leaves towards the end of January. If this bird visits the Chathams from Australia it is remarkable (as Capt. Hutton has observed) that it must pass over the large islands of New Zealand and extend its flight an additional 450 miles.

56. *Carpophaga novæ-zealandiæ.*

Now common on all the islands, and abundant on Mangare, where it breeds. It is said to have made its first appearance on the islands about 1855. Eggs whitish, spotted with brownish-pink on the larger end. Length 1·47 in., diameter 1·07 in.

64. *Charadrius bicinctus.*

Not common, and found chiefly in open grassy country.

65. *Thinornis novæ-zealandiæ.*

I only found this bird on Mangare and on parts of the coast of Pitt Island. It has been called the "bowing-bird" by the settlers, from its habit of bowing its body when approached.

68. *Hæmatopus longirostris.*

Not common and usually found on sandy beaches.

74. *Ardea poiciloptera.*

I did not obtain a specimen of this bird, which has become very rare on the Islands, but I was informed by persons who had seen it, and who knew the New Zealand bird, that it was precisely similar.

76. *Limosa uropygialis.*

I did not obtain a specimen of this bird, but was informed that it visited the islands in spring, leaving them in the autumn.

83. *Gallinago pusilla.*

I only found this bird on Mangare, where it is not common. I never saw it on the wing except when disturbed, and, being very tame, it then only flies a short distance. It lives in holes in the rocks, coming out towards evening to feed. Its chief food is worms and grubs, for which it scratches the ground much in the manner of a fowl; from this habit the settlers have given it the name of the "chicken-bird." Its cry is peculiar, something like the note which is produced by blowing into a hollow reed at one end of which a finger is placed and frequently and suddenly removed. This note is repeated rapidly six or seven times. The holes it inhabits are about eighteen inches deep, and evidently artificial. In the two instances in which I obtained young birds in the nests there was only one bird in each case. I could not detect any difference in plumage between the sexes.

—. *Rallus modestus*, sp. n. Hutton.

Matirakahu of the Morioris. Of this bird, which I only found on Mangare, I obtained two specimens, one a full grown female, and the other a young one. It is not known on any of the other islands, and although I was on Mangare for twelve days these were the only specimens I saw. The birds in question were found in a very rocky place, and when disturbed sought to hide themselves amongst the stones. I had no opportunity of studying its habits, and having unfortunately failed in obtaining the male parent bird, I am unable to say whether its plumage is different from that of the female. It appears to be a nocturnal bird, as those I obtained came out of the rocks at dusk, evidently to feed. Both the parent birds had escaped in the first

instance, but the female was attracted by the plaintive cry of the young one which I had caught. I caught sight of the male bird also, but it was too dark to pursue it amongst the scrub.

90. *Ortygometra affinis.*

I obtained this bird on Chatham Island. It inhabits wet swamps, and is very rare and difficult to obtain. When hunted with dogs it takes wing, but only for a short distance, and, after dropping, it runs with great rapidity through the long sedges and swamp grasses. Many of the oldest white inhabitants had never seen it, and the Maoris but seldom. In the only specimen I obtained was an egg, which was unfortunately broken during the dissection of the bird for ascertaining the sex. The egg was about the size of an ordinary walnut, of a brownish-olive colour, spotted with darker brown.

92. *Ortygometra tabuensis.*

This bird is extremely rare, and occupies grassy spots in swampy places. I only obtained one young specimen.

94. *Porphyrio melanotus.*

Common on the banks of the lagoon on Chatham Island, but rare on Pitt Island, and not found on the smaller ones.

99. *Anas superciliosa.*

Common throughout the islands.

100. *Rhynchaspis variegata.*

Not common, and chiefly found in small lagoons.

106. *Lestris catarractes.*

The common name of this bird amongst sailors is the "sea-hen." I only found it in certain places on Pitt Island, and on a small islet about two miles from that island. It commences breeding in the beginning of December. The eggs, two in number, are laid on a nest roughly made of grass, and placed on rocky spots near the shore. The egg and nest are scarcely distinguishable from those of *Larus dominicanus*, except that the former are a little larger. One egg only is usually hatched. Whilst attempting to take the eggs of these birds both parents attacked me most savagely, and I had some trouble in obtaining them. Both parents take part in the work of incubation. Round the nests I found remains of several small sea birds, chiefly *Prion turtur*. During the day time I saw this bird usually sitting in sunny places on the higher cliffs, only now and then taking short flights. I never saw it hunting for food during the day time, but whilst I was on Mangare I heard it constantly during the night, swooping at the small birds which come on shore to roost. I examined the stomachs of a good many, always finding the

contents to be *Prion turtur*, usually swallowed whole. This bird also attacks the young of the domestic fowl, frequently clearing off whole broods, where they breed in the bush. It attacks the albatros very savagely, and generally succeeds in driving it from its prey. Its flight is somewhat the same as that of *Larus dominicanus*, but it flaps the wing more rapidly than that bird. There is very little distinction in plumage between the male and female.

108. *Larus dominicanus.*

109. *Larus scopulinus.*

Both these birds are common, the former breeding on the banks of the big lagoon, and the latter in the same locality, and on the banks of smaller lakes.

113. *Sterna frontalis.*

A spring and summer visitor to the islands, where it first appears in August, but I am unable to say at what time it leaves. It breeds in October on the banks of the small lakes, and on rocky places near the coast.

119. *Diomedea melanophrys.*

Found on Pitt Island, where it probably breeds.

123. *Ossifraga gigantea.*

Stink-pot of the American whalers. This bird is difficult to obtain, except where the carcase of a whale or seal is cast ashore. It usually flies at a great height, but when a whale carcase is afloat they settle on it in thousands. Their flight is generally like that of the albatros, but they flap the wings oftener than that bird. Their power of scent appears to be wonderful. By good fortune I obtained the carcase of a large seal, and after taking off the skin I placed it in a quiet pool amongst the rocks. It had not been there more than an hour when at least forty of these birds attacked it, although I only observed one within sight before the carcase was placed in the pool. They are very wary, and do not settle until they have carefully examined their prey, and then only settle in the water swimming up to the food. They gorge themselves to such an extent as to become incapable of flight. On first landing on Mangare I found a number of these birds, which had gorged themselves on a shoal of fish which had been driven ashore, and several that I picked up and threw into the air fell again like stones. In several that I opened I found remains of fish and of *Prion turtur.* They breed in November, laying only one egg at a time. Like the albatros they only breed on rocky islets destitute of vegetation, the nests being placed on the edges of the cliffs.

124. *Halodroma urinatrix.*

Common on Pitt Island, and occasionally found on Mangare.

127. *Puffinus tristis.*

Common all round the coasts of the Chatham group. It burrows a horizontal hole, from three to four feet deep, and turning slightly to the right or left, in peaty ground. At the extremity of this hole it forms a rude nest composed of twigs and dead leaves. Only one egg is laid, and the male bird assists in the work of incubation. They are very savage whilst on the nest, biting and scratching those who molest them. The young bird is singularly fat, and when taken from the hole disgorges a quantity of oily matter of most offensive smell. This, however, is esteemed a delicacy by the Morioris, who hold the young birds over their mouths allowing the substance to drain into them. The old birds roost on shore, the noise they make during the whole night being absolutely frightful, resembling an exaggerated chorus of squalling children and love-making cats, in which the performers were numbered by thousands. From the manner in which this noise was intensified on each fresh arrival I could only conclude that the whole lot were squalling out their adventures during the day. When taken out of their holes they flutter about on the ground for some time, tumbling over stumps in a confused manner, but ultimately make for the sea.

139. *Prion turtur.*

Right-whale bird of the whalers. This bird occurs in immense numbers on the islands. It breeds in holes in the ground, laying a single egg in a nest composed of a few dead leaves. Both parents assist in the incubation. When the bird is taken from the hole it disgorges a quantity of greenish oily matter, which appears to be used as food for the young birds. Whilst on Mangare I often found these birds caught in the branches of scrubby trees, and could only account for this by supposing that they got caught whilst attempting to escape from *Lestris catarractes.* Egg pure white; length 1 in., diameter, 1 in.

141. *Prion vittatus.*

Blue Billy of the settlers. Breeds in cavities of cliffs on the sea shore, or in holes burrowed in the soft peaty soil which covers the tops of most of the small islets. The hole dips slightly, is from eighteen to twenty-four inches deep, and quite straight. It breeds in September, and only one egg is laid. Where the egg is laid in holes in rocks it is placed on the bare rock, but in the peaty holes a few leaves are found, but whether placed there by this bird or by smaller sea birds which use the same holes for breeding I cannot say. Both birds take part in incubation. They are not easily disturbed when sitting, pecking at the hand whilst the egg is being taken, but remaining on the nest after its removal. When taken from the holes they fly away with a wavy uncertain flight as if blinded by the sudden light. One mode of getting this and other sea birds is by lighting a large fire at night at the foot of a high

cliff, against which they dash themselves or, becoming stupified, are easily knocked down. In a cave on Pitt Island, which I reached by the aid of a rope, I found a cat which had eaten the heads off nearly a hundred young birds without the bodies being touched. Many old birds had also been killed by this cat. How it got there I cannot imagine. The egg is pure white; length 1·95 in., diameter 1·47 in.

142. *Thalassidroma marina.*

Common all round the islands. They are attracted by a fire at night, numbers throwing themselves into it. I have often felt them strike my tent, attracted by the light of the lamp. This bird walks with great difficulty owing to the length of the tarsus. I was informed that it breeds in the end of January.

147. *Graculus carbo.*

Not uncommon on the lagoons, but very shy.

148. *Graculus carunculatus.*

Not common. It breeds on a small islet near Pitt Island in November, but as I was then absent from Pitt Island I did not get the egg. It only comes on shore to roost on trees, generally fishing all day at some distance from the land.

—. *Graculus africanus?*

Like *G. carunculatus* this bird is only found in certain parts of Pitt Island. It breeds in November on the most inaccessible cliffs. I had much difficulty in obtaining specimens.

158. *Eudyptes pachyrhynchus.*

I obtained and brought to New Zealand a live specimen of this bird, which had come on shore to moult. I believe it to have been a young bird. It remained for nearly three weeks without food, but on reaching New Zealand it was fed partly on fish and partly on raw meat. It became very tame, following like a dog any one who fed it. It was unable to take its own food, which had to be placed in the gullet. It became very fat and appeared to thrive, but, unfortunately, I was unable to get fish for several days, owing to stormy weather, during which it was fed on meat. It died somewhat suddenly, which I attribute to the nature of the food, as, on being opened, it presented no appearance of disease. It used its flippers in climbing, and by their aid was able to travel up very steep places if at all rough. Nothing could be more quaint than the habits and appearance of this bird as it wandered about the garden, or followed those it knew. Though generally considered stupid, no doubt from its appearance, it was extremely cunning. When placed at night in an inclosure with some poultry it became master of

the situation, its harsh cry and powerful beak striking terror into the other occupants.

159. *Eudyptula minor.*

Very common in rocky places about Pitt Island, where they live in holes and fissures. They usually come on shore about ten at night in the summer, and it was very amusing to see the ingenious manner in which they used their flippers in climbing.

Art. XXIII.—*Notes on some of the Birds brought by Mr. Henry Travers from the Chatham Islands, with Descriptions of the New Species.*

By Capt. F. W. Hutton, C.M.Z.S.

[*Read before the Wellington Philosophical Society, 23rd October,* 1872.]

In the following notes I have alluded only to those birds which are either new to our fauna or which have some special point of interest. A complete list of the birds known to inhabit the Chatham Islands will be given by Mr. H. Travers (see Art. xxii.) as well as descriptions of all the eggs that he collected.

Gerygone albofrontata, Gray.

G. albofrontata, Gray, "Voy. Ereb. and Terr.," Birds, p. 5, Pl. IV., fig. 2.

Two specimens of this species were obtained on Pitt Island, but neither are in good condition; they differ considerably from the measurements given by Mr. G. Gray, but as Dr. Buller says in his "Birds of New Zealand" that the original specimen in the British Museum is labelled as coming from the Chatham Islands, there can be no doubt as to their identity.

Above olivaceous brown; forehead, over the eye, region of the ears, and all the under surface, white; tinged with yellow on the flanks, abdomen, and vent; quills brown, narrowly edged on the outside with olivaceous; secondaries the same but with a broader edging; tail brownish rufous, with a brownish black band near the tip, followed on the three outer feathers with a pale rufous band; tips brown; irides light red.

Length 4·5 in.; wing from flexure, 2·25; bill from gape, ·65; tarsus, ·87.

In the "Ibis" for last July, Mr. Potts describes a specimen of *Gerygone* procured by him on the west coast of the South Island (see Art. xix), which specimen Dr. Buller refers, from Mr. Potts' description, to *G. albofrontata*; but in this opinion I cannot agree, for Mr. Potts' specimen, as he describes it, differs from *G. albofrontata* not only in the absence of the white forehead but also in the dark colour of the wings, in having the two centre tail feathers

black, and in the chin, cheeks, and breast being grey, in all which respects it agrees with *G. flaviventris.*

Miro traversi, Buller.

Petroica traversi, Hutton, "Ibis," July, 1872. *Miro traversi,* Buller, "Birds of N.Z.," p. 123.

Entirely black, except the wing feathers, which are brownish. Length, 6 in.; wing from flexure, 3·25; bill from gape, ·77; tarsus, 1·13. There is no difference between the sexes.

Rhipidura flabellifera, Gml.

R. flabellifera, Gray, "Voy. Ereb. and Terr.," Birds, p. 8.

One specimen only was procured, which on a second examination I find has the white of the tail feathers purer than in specimens from New Zealand, those from the North Island especially having the white on the tail more or less clouded with brown.

Platycercus auriceps, Kuhl.

P. auriceps, Hutton, "Cat. Birds N.Z.," p. 19.

Two specimens, both of which are larger than any that I have seen from New Zealand, measuring 11 inches in length, and wing from flexure 4·7. The bill and tarsus are of the same size as New Zealand specimens.

Chrysococcyx plagosus, Lath.

Lamprococcyx plagosus, Gould, "Handbook to Birds of Australia," I., p. 623.

The Chatham Island birds have but faint traces of rufous bars on the inner web of the second tail feather, thus agreeing, I suppose, with the Australian species and not with the one from New Zealand, but I have no Australian specimens for comparison.

Rallus? modestus, Hutton.

R. modestus, Hutton, "Ibis," July, 1872.

Olivaceous brown, bases of the feathers plumbeous; feathers of the breast slightly tipped with pale fulvous, those of the abdomen and flanks with two narrow bars of the same colour; throat dark grey, each feather slightly tipped with brown; quills soft and short, brown, the first three faintly barred with reddish fulvous; fourth and fifth quills the longest; tail very short and soft, brown; irides light brown; bill longer than the head, rather slender, curved downwards, brown; legs dark brown (dry).

Length, 8·75 in.; wing, 3·15; bill from gape, 1·4; tarsus, 1; middle toe and claw, 1·4.

Young covered with brownish black down.

This curious bird was found on Mangare only; it will, doubtless, form the type of a new genus, as no other rail has a curved bill.

Halodroma berardii, Quoy.

Pelecanoides berardii, Q. and G., "Voy. de l'Uran.," Zool., pl. 31. Pl. col. 517.

This species is distinguished from *H. urinatrix* by its narrow bill, which is only ·17 inches in breadth at the end of the nasal tubes, while in *H. urinatrix* it is ·25 in.

Phalacrocorax carunculatus, Gml.

Graculus cirrhatus, Gray, "Voy. Ereb. and Terr.," Birds, p. 19.

Several specimens were obtained. Legs and feet flesh coloured.

Length, 27·5 in.; wing, 10·5; bill, 3·25; tarsus, 2.

As soon as the breeding season is over they lose the dark blue-black on the back, and get instead brown with a broad white transverse band.

Phalacrocorax africanus, Gml. ?

Graculus africanus? Hutton, "Ibis," July, 1872.

Head, neck, throat, lower part of the back, thighs, vent, and over the tail, dark blue- or green-black; upper back and wing-coverts greenish bronzy brown, each feather with a black apex; breast and abdomen grey; quills and tail brownish black; head crested; neck ornamented with white feathers in the breeding season; bill dark coloured; legs and feet yellowish orange.

Length 19 in.; wing, 9·5; bill, 2·75; tarsus 2.

In the "Ibis" for last July I referred this beautiful species to *G. africanus* with some doubt, as the only descriptions available, those of Linnæus, Cuvier, and Layard, in his "Birds of South Africa," were very short and disagreed among themselves, but still seemed to indicate a bird very like ours. By the last mail, however, I heard from Dr. Finsch that Dr. Buller has sent him a specimen for examination, and that he (Dr. Finsch) considered it as a new species; it is certainly distinct from *G. longicaudus*, Swainson ("B. of Africa," II., p. 253) which Mr. Gray considered the same as *G. africanus*. It is also found in New Zealand, for I have seen fragments in a lady's hat of a specimen that was shot at the Wade near Auckland.

ART. XXIV.—*Notes on some of the New Zealand Birds.* By JAMES MORTON. (Communicated by Capt. HUTTON.)

[*Read before the Wellington Philosophical Society, 20th July,* 1872.

Graucalus concinnus, Hutton.

Colluricincla concinna, Hutton, "Cat. Birds N.Z.," No. 40.

A specimen of this species was shot at a farm four miles from Invercargill, and the skin is now in my possession.

Platycercus, sp.

I think that we have near Invercargill another species of paroquet, which differs from *P. auriceps* in being of a much bluer green, with a band of orange on the forehead, and one of light yellow above it; the spots under the wings and on each side of the rump orange, corresponding with the forehead. It is about the same size as *P. auriceps.* (See note by Captain Hutton.)

Ardea alba, L.

I have had great experience in handling and watching the habits of this bird, having been to the breeding-places on several occasions, and having kept two in confinement for six months. They had to be treated with great caution to preserve their health, for although they well knew the hand that fed them, and would always recognize me, still if I came upon them suddenly, or in any way disturbed them beyond what they were accustomed to, they would instantly vomit and sometimes remain sick all day, or even for two or three days at a time, and would sometimes lose the power of their legs.

After a close study I came to the conclusion that this bird is three years in arriving at maturity.

The first year they are pure white, with the skin on the sides of the head greenish or greenish yellow; bill yellow; legs black.

In the second year the bird increases in size and the dorsal plumes appear a little in May, and the tip of the upper mandible commences to get dark.

In the third year the dorsal plumes are elongated beyond the tail in a most graceful manner; the bill is now black or dusky, and the base of the bill along with the naked skin round the eye is of a beautiful bright blue. Both male and female have the power of erecting their dorsal plumes at pleasure in a similar manner to the peacock; this I have seen them do on their nests, uttering their hoarse croak at the same time.

The adult bird is migratory, but to what extent I am not yet certain, but all birds shot near Invercargill throughout the winter are young birds of the first and second year.

Ardea sacra, Gml.

Captain Hutton's description hardly answers to the birds here; I should call it a dusky black. This bird has also got dorsal plumes.

NOTE.—The paroquet referred to by Mr. Morton is no doubt *P. alpinus*, Buller, which both Dr. Finsch and Dr. Buller consider to be the young of *P. auriceps*. When compiling my catalogue I followed them in uniting *P. alpinus* with *P. auriceps*. I now feel some doubt as to the correctness of this, but think that more evidence is yet required before *P. alpinus* can be accepted as a good species.—F. W. HUTTON.

ART. XXV.—*Note on* Colluricincla concinna, *Hutton.*

By Capt. F. W. HUTTON, C.M.Z.S.

[*Read before the Wellington Philosophical Society, 14th August*, 1872.]

IN the "Catalogue of the Birds of New Zealand," which was published last year I described a bird in the Nelson Museum under the name of *Colluricincla concinna* ("Cat. Birds N.Z.," No. 40, p. 15). Further inquiry led me to think that I had made a mistake, and that the bird in question was identical with *Graucalus melanops* of Australia. A short time ago another specimen that had been shot near Invercargill in April, 1870, was received at the Colonial Museum, and I was thus enabled to compare this New Zealand bird with two specimens of *Graucalus melanops* from Australia. The result of this comparison has been to show that the New Zealand bird differs from the Australian in having a more slender bill, a rather longer tail, the feathers of which are acutely pointed at the tip instead of being rounded, and in having much more white on the wings. Like the bird shot in the Nelson province this one also has the general plumage of the young of *G. melanops*, but the feathers of the chin and forehead are similar to those on the throat and top of the head, and not lighter as in *G. melanops*; there is also no indication of any black feathers coming on the chin or upper part of the head. These differences are, I think, quite sufficient to warrant its being kept as a distinct species.

The following is a description of the specimen:—

Graucalus concinnus.

Colluricincla concinna, Hutton, "Cat. Birds of N.Z.," No. 40, p. 15.

The whole of the upper surface uniform pale grey, the feathers of the forehead with the shafts darker; feathers of the throat and breast pale grey, slightly tipped with white, those of the upper abdomen and thighs pale grey, with white circular bands; lower abdomen, vent, and under tail-coverts pure white; a broad band of black passes from the nostrils and gape through and below the eye to the region of the ears; primaries brownish black, the first slightly tipped with white, the second, third, fourth and fifth margined outwardly and slightly tipped with white, the remainder margined all round with a white band which is broader on the tip and inner web; secondaries

greyish black, with more or less grey on the outer webs near the base, and with a rather broad white margin on the outer web and tip; *greater wing-coverts margined outwardly with white*; *tail feathers acutely pointed at the tip*, the two middle ones brownish grey, laterals brownish black tipped with white, the white decreasing inwards; shafts of the tail-feathers greyish black above and pure white below; bill (dry) brownish black, paler at the base; legs and feet (dry) black.

MEASUREMENT IN INCHES.

	G. concinnus, (New Zealand).	*G. melanops*, (Australia), 2 examples.
Wing	8	8
Tail	7	6·5
Tarsus	1·1	1·1
Hind toe	·8	·8
Middle toe	1·1	1·1
Bill,—Culmen	·85	·85
„ Breadth at nostrils	·4	·5
„ Height at nostrils	·35	·46

This bird was shot on or about the 8th April, 1870, in an apple tree near Invercargill, Southland.

NOTE.—Since reading this paper Mr. Mantell has informed me that he saw this bird many years ago at Port Chalmers, in Otago; Mr. W. Travers says that he has seen it in Nelson, and Capt. Fraser says that he saw it near Hawea Lake, in Otago.—F. W. H.

ART. XXVI.—*On the Geographical Relations of the New Zealand Fauna.* By Capt. F. W. HUTTON, C.M.Z.S.

[*Read before the Wellington Philosophical Society, 4th and 11th September,* 1872.]

I KNOW of no part of the world that presents such a promising field to the student of Nature as New Zealand. Although small in size it contains a fauna and flora so peculiar that several naturalists consider it as a separate biological province apart from the rest of the world. Isolated from any large continental area longer probably than any other portion of the earth, it contains the remnant of the population of a continent that existed before the Mammalia had overspread the world, and to that has at various times been added, principally from Australia, a colonist population which culminated not many hundreds of years ago in the advent of man. New Zealand, therefore, presents us with what I may call the elements of a continental fauna, or a

continental fauna in its simplest state, and consequently in that state which is most advantageous for studying the mutual relations of the animals composing it.

Both Mr. Darwin and Mr. Wallace call New Zealand an "oceanic island" from a zoological point of view, owing to the absence of terrestrial Mammals, and the meagreness of its fauna and flora; that is to say they consider it as an island that has never formed part of a continental area since its last emergence from the sea. But I think that the Struthious birds have certainly as much weight in determining this point as terrestrial Mammals, for they have no superior means of dispersion, and New Zealand also possesses a frog, which is one of the great characteristics of a continental fauna. From a geological point of view I do not see how any land, except volcanic and coral islands, could have originated except as part of a large continental upheaval. I think, therefore, that the New Zealand fauna may be correctly called the remnants of a continental fauna, and that a close study of it will throw great light on many of the most important, but at the same time most obscure, problems in zoology. It will, however, be long before this can be accomplished. The describing and naming of the different animals, which is the foundation upon which all other researches must rest, is as yet far from being completed; the determination of what species are the original inhabitants, or the descendants of the original inhabitants, of the former continent, has hardly been attempted, but all this must be settled before any sound deductions can be drawn as to the reasons of extinction, variation, or permanency of type, of the animals.

It is to this latter point that I wish to draw attention, not that I am in possession of information sufficient to prove any one, perhaps, of the points that I shall raise, but because I think that sufficient is known to establish with great probability the main features in the zoological history of these islands, and this sketch, which I now presume to offer you, will I hope induce others to examine the subject more in detail, and will give a systematic direction to their observations. I propose to take first the zoological evidence —to point out the principal facts that have to be accounted for, and the deductions that they lead to. I will then rapidly glance at the geological and palæontological evidence, and finally I will draw up from the whole the hypothesis that appears best able to account for all the phenomena.

Mammalia.

Of our two bats one (*Scotophilus tuberculatus*), although not found elsewhere, is closely allied to those of Australia, while the other (*Mystacina velutina*) forms the only species of a genus peculiar to New Zealand, but related to bats living in South America.

Two species of seal frequent our shores; the sea leopard (*Stenorhynchus leptonyx*) which is also found on ice floes in the Antarctic seas, and occasionally extends to Australia, and the fur seal (*Arctocephalus cinereus*), which is supposed to occur also on the southern coasts of Australia, and is closely related to, if not identical with, a species found at the Falkland Islands, Cape Horn, South Shetland, and South Georgia. In the Otago Museum there is also a skull that appears to belong to the sea elephant (*Morunga proboscidea*). Mr. Purdie informed me that it was picked up a long way inland.

Of the Cetacea some twelve or thirteen species are known, belonging to the six different families into which the marine members of this order have been divided, and it is remarkable that two thirds of them are endemic, that is not found anywhere else. Our two or three species of whale-bone whale have, up to the present, been found nowhere else. The sperm whale of our northern coasts is probably the same species as that found in Australia and the South Pacific (*Catodon australis*). It is certainly distinct from the northern sperm whale (*C. macrocephalus*) as the lower jaw is much narrower.*

Our ziphoid whales, of which we have three or four species, are all endemic, and two of them (*Berardius arnuxii* and *Mesoplodon hectori*) belong to genera not found elsewhere. None, however, of our *Delphiniidæ* are confined to New Zealand. *Delphinus novæ-zealandiæ* inhabits the antarctic seas, and perhaps Tasmania; *Lagenorhynchus clanculus* is found throughout the Pacific Ocean, but not in Australia, and *Orca capensis*, a lower jaw of which is in the Auckland Museum, ranges from the Cape of Good Hope through the Southern Ocean to Chili, and is also found in the North Pacific and Tasmania. The black-fish (*Globiocephalus macrorhynchus*) is found in the South Pacific and Japan, but not in Australia. Our Cetacea therefore, contrary to what might have been expected, show a nearer relation to the Pacific and Antarctic Oceans than they do to Australia, and it is remarkable that no species of porpoise has as yet been described as found in New Zealand, although two inhabit Tasmania.

The absence of terrestrial Mammalia is one of the chief points of interest in New Zealand zoology, as it proves that there has been no land communication between this country and Australia since the latter was inhabited by Marsupials, for I consider that the so-called Maori rat and native dog were both introduced by human agency.†

* Capt. Cook remarks in his first voyage that rats were "so scarce that many of us never saw them." (Hawkesworth's "Coll. of Voy.," III., p. 34.) He makes no mention of them ever being used for food, and I am not aware of any remains of rats having been as yet found in Maori cooking places.

† A lower jaw of the New Zealand sperm whale in the Auckland Museum is 17 ft. 7 in. in length, and only 2 ft. 2 in. in width at the condyles; there are 23 teeth on each side, 4 of which are rudimentary only; the length of the largest tooth is 7·4 in.

Sir George Grey informs me that he sent to the British Museum some grey "Maori rats" which had been caught in the interior of the South Island in 1847 by Mr. Torlesse, and that Dr. Gray had said that they were identical with a rat found in Polynesia, by which he must have meant the black rat (*Mus rattus*) for none of the islands in the Pacific possess an indigenous rat. Dr. Buller also collected a considerable amount of evidence to show that the "kiore-maori" was identical with a rat—now in the Colonial Museum—which he described (*Trans.* N.Z. Inst., III., p. 1) under the name of *Mus novæ-zealandiæ*, but which is certainly *Mus rattus.* Mr. Colenso says ("Proc. R. Soc. of Van Diemen's Land," 1851, p. 301), in a letter to R. Gunn, Esq., dated 4th Sept., 1850, that after considerable trouble he had procured two specimens of the native rat, which he describes as "smaller than our English black rat (*M. rattus*) and not unlike it." Against this we have the statement of Dr. Dieffenbach, who says ("New Zealand," II., p. 185) that it was the English and not the Norway rat that killed off the "kiore-maori." This, I think, must be a mistake, as all the Maoris attribute the destruction of the edible rat to the brown rat, and it could only have been from Maoris that Dr. Dieffenbach got his information. Mr. Murray also states ("Distr. of Mammals," p. 277) that the Norway rat (*M. decumanus*) was not introduced into New Zealand in 1843, but he gives no evidence of the truth of this statement, and it is unquestionably erroneous.* The whole of the reliable evidence that we have, therefore, goes to prove that the Maori rat was no other than *M. rattus.*

The so-called "native dog" has been determined by Dr. Gray to be *Canis familiaris* ("Pro. Zool. Soc.," 1868, p. 508), and not the Australian species, or variety, called *Canis dingo*, which is the strongest possible evidence of its being merely an escaped domestic breed; indeed, I am not aware that any naturalist believes in an indigenous native dog except Dr. Haast, who has argued (*Trans.* N.Z. Inst., IV., p. 88) that a wild dog existed in New Zealand before the domesticated one, because in certain old Maori cooking places he has found remains of the dog but no gnawed bones, while in others, which he considers as of later date, he finds gnawed bones.† But I am not aware that

* Since reading this paper Mr. Nichol has informed me that the brown rat was common in Nelson when he first arrived in the early part of 1842, and that he never saw any other kind there except a single specimen of a very large and slightly striped variety.

† The skulls of dogs found in old Maori cooking-places prove undoubtedly that *Canis familiaris* existed in New Zealand long before Europeans came here. Captain Cook says (21st October, 1769) that the dogs were "small and ugly," and Mr. Anderson ("Cook's 3rd Voyage," I., 153) calls it a "sort of fox-dog." Capt. Cook also says in his first voyage that the dog was used for no other purpose than to eat. The fact that the inhabitants of the Friendly Islands have the same name (*kuri*) for the dog as the New Zealanders is strong evidence that the latter brought it with them, for if not they would have lost the name as they have done that of the fowl.

he has any proof of the existence of a dog in New Zealand before the arrival of man, and the difference of date of these cooking-places for which Dr. Haast contends, is denied by many observers, and his argument derived from the presence or absence of ground stone implements has, I think, been successfully controverted. I can therefore attach no weight to the absence of gnawed bones. On the other hand, there is the fact that no indigenous dog or rat has ever been found on an island that was not inhabited by other Mammalia, and when we remember that Marsupials came into existence long before rats and dogs, it is difficult to see how the latter could possibly get to any country without the former coming also. It is evident that neither Banks, nor Solander, nor the Forsters, considered the dog and rat that they found in New Zealand as a new species, or they would certainly have mentioned it; neither did Lesson in 1827, nor Quoy and Gaimard in 1831. Dr. Dieffenbach, in 1842, was the first to state that a frugivorous rat, distinct from *M. rattus*, existed in New Zealand; he, probably, not being aware that *M. rattus* is entirely frugivorous. I am therefore of opinion that both the rat and the dog were brought by human agency, and it is worth remarking that the Maori traditions relate that they brought both with them. (Travers, *Trans.* N.Z. Inst., IV., p. 58.) The specimen of *Mus gouldi* in the Auckland Museum (see *Trans.* N.Z. Inst., III., p. 3) was caught, I believe, at the Thames in January, 1853, and as a mission station had been established there some years previously this specimen was no doubt brought over from Australia in their vessel.

The animal seen at Dusky Bay by some of Capt. Cook's sailors (2nd Voyage, I., 98) was probably a dog, as none on board had at that time seen a dog in New Zealand.

The evidence of a kind of otter inhabiting the South Island rests upon some foot-prints seen by Dr. Haast, and mentioned by him in his first presidential address to the Canterbury Philosophical Society ("Nat. Hist. Rev.," 1864. p. 30). In the same address he also mentions having seen tracks in great numbers of a small jumping mammal in the riverbed of the Hopkins, but as no further evidence of the existence of these creatures has been adduced, although eight or nine years have since elapsed, it is impossible for me to take any further notice of them in this paper.

BIRDS.

The first point that claims our attention here is the great development of the Struthious birds. This division can be subdivided into two families, one (*Apterygidæ*) containing only the kiwis, and the other (*Struthionidæ*) including all other living forms as well as the extinct moas. The kiwis in the structure of the egg-shell have an affinity with the Carinate division of birds. Their

short legs, and the presence of a hind toe elevated above the level of the others, shows an approach to the Gallinaceous order, while their long bill, with its slightly swollen tip, resembles in some measure that of the *Scolopacidæ*, which have also the same habit as the kiwi of feeling about on the ground with their bill. *Gallinago pusilla* moreover lives in holes, and only comes out at night (Travers, see Art. xxii).

Thus the *Apterygidæ* have a more generalised structure than the other Struthious birds; they therefore belong to an older type, and cannot with any degree of correctness be said to represent the extinct race of moas. The relations between the second family, or the *Struthiones* proper, are very complicated, but *Dinornis*, which alone concerns us here, appears to be intermediate between the rheas of South America, and the emus and cassowaries of Australia and the adjacent islands. It approaches the rhea in the structure of its egg-shell and in having only three pairs of sternal ribs, while the emu, the cassowary, and also the kiwi, have four, and the ostrich five pairs. In the structure of its feathers, and in the shape of its pelvis and skull the moa approaches the emu. The Struthious birds exhibit a type of structure intermediate in many respects between the Carinate birds and the extinct Dinosaurians, and this leads naturalists to suppose that they are but the remnant of a race that once spread over the whole earth. About twelve species are known outside New Zealand; while here, besides our four species of *Apteryx*, Professor Owen has determined fourteen species of *Dinornis*, three of *Aptornis*, and one of *Cnemiornis*, thus making a total of twenty-two species of Struthious birds, belonging to four different genera, living in New Zealand only a few hundred years ago, that is to say, nearly twice as many as are found in all other parts of the world put together.

Probably, however, some of Professor Owen's species of *Dinornis* are but the young of others, and it seems to me very doubtful whether *Aptornis* and *Cnemiornis* should be regarded as Struthious birds at all. It is evident that these two genera are closely related, and if the wing bones placed upon *Cnemiornis calcitrans* really belong to the legs of the same bird we must suppose that the sternum had a keel sufficiently developed to support muscles of a size proportionate to the wings; for although we can understand how the kakapo (*Stringops*), belonging to an order of deeply keeled birds, may have lost, by disuse of the pectoral muscles, the keel on its sternum, we cannot possibly explain how a Struthious bird could have had large wing bones developed unless it had also sufficiently powerful muscles to use them. I also observe that *Aptornis defossor* now wears a skull similar to that of the late *Dinornis casuarinus*, which skull Mr. W. K. Parker says undoubtedly belonged originally to a *Notornis*. But omitting these two genera, and making a due allowance for doubtful species of *Dinornis*, the great number of

species living on so small an island is very remarkable when contrasted with other parts of the world. The continent of Africa, including Arabia, contains but one, or according to some naturalists two, species of ostrich. South America, from Patagonia to Peru, has but three species of rhea, each inhabiting a separate district. Australia possesses two species of emu, one on the eastern and the other on the western side, and one species of cassowary on the northern, while five other species of cassowary inhabit other detached islands, from New Britain and New Guinea to the Molucca Islands. I believe that outside of New Zealand no two species of Struthious bird are found living in the same district, while here we have now four species of kiwi and not long ago had at least half-a-dozen species of moa as well. How can this be accounted for? The solution is readily found by examining the distribution of the cassowaries. Here we have six species inhabiting six isolated localities. If now this region of the earth were to be elevated these six species might mingle, and if it were subsequently to sink again, all six species would undoubtedly be driven to the higher lands, and we should have in this supposed island a representation of New Zealand inhabited by six species of Struthious bird.

In order, therefore, to account for the numerous species of *Dinornis* we must suppose an ancient continent, inhabited by one or two species, to sink, and the birds to take refuge on the different mountain ranges left as islands above the water. We must suppose that they remained thus isolated from one another for a sufficiently long period to allow of specific changes being brought about; that then, by an elevation of the land they once more mingled together, and that, on subsidence again taking place, New Zealand as the central mountain chain formed a harbour of refuge for them all.

Whether this isolation of species points to some cause as yet unrecognized, by which in the struggle for life no two species of Struthious bird can live in close proximity I will not venture to give an opinion, but it is a fair subject for inquiry, and one on which the careful study of the relative ages of moa bones might throw considerable light, and enable us perhaps to understand the great mortality that must have taken place amongst the moas when confined to these small islands long before man set his foot here.

The distribution, therefore, of the Struthious birds in the Southern Hemisphere points to a large Antarctic Continent stretching from Australia through New Zealand to South America, and perhaps on to South Africa. This continent must have sunk, and Australia, New Zealand, South America and South Africa must have remained isolated from one another long enough to allow of the great differences observable between the birds of each country being brought about. Subsequently New Zealand must have formed part of a smaller continent, not connected either with Australia or South America,

over which the moa roamed. This must have been followed by a long insular period, ending in another continent still disconnected from Australia and South America, which continent again sank and New Zealand assumed somewhat of its present form.

Passing now to the Carinate division of birds the first thing that strikes us is the fragmentary nature of this part of our avi-fauna (if we exclude the Grallæ and Web-footed birds), thus strongly contrasting with the Struthious division.

Of the first six orders we possess, excluding the Chatham and Auckland Islands, forty-five species, thirty of which are endemic. These have been referred to thirty-one genera, ten of which are found nowhere else, and these thirty-one genera belong to twenty families, one of which (*Stringopidæ*) is peculiar to New Zealand. Two families only, the honey-eaters (*Meliphagidæ*) and the starlings (*Sturnidæ*) contain more than two genera. The first shows affinity to Australia, but it must be remarked that out of the four species of this family, belonging to four different genera, one genus only (*Zosterops*) is found in Australia, and the little bird (the "white-eye") that belongs to this genus is known to be quite a recent arrival in this country. The *Sturnidæ* on the other hand show an affinity with Polynesia, for one species only (*Calornis metallicus*) of this family is found in the north of Australia and New Guinea. It should, however, be noticed that three other species are found in the latter island. In this family also our three species belong to three different genera, two of which (*Creadion* and *Heteralocha*) are found nowhere else, while the other (*Aplonis*) is very characteristic of Polynesia, and *Aplonis caledonicus*, which is said to have been found in New Zealand, occurs also in Norfolk Island and New Caledonia.

It is remarkable that our two owls should both be peculiar to New Zealand, and that one of them (*Sceloglaux albifacies*) should belong to a genus not found elsewhere, for the owls are usually widely spread birds, more so indeed than the hawks. It is also worthy of notice that *Strix delicatula*, which extends its range over most of the Pacific Islands and Australia, should be absent from New Zealand.

Our parrots present several points of interest. The kakapo (*Stringops habroptilus*) is found nowhere else, the genus *Nestor* extends only to Norfolk Island, while our paroquets, although belonging to a genus (*Platycercus*) equally plentiful both in Australia and Polynesia, show a greater affinity to the latter, one species (*P. novæ-zealandiæ*) ranging not only to Norfolk Island but also to New Caledonia. It is remarkable that we have no representatives of the cockatoos and grass-paroquets so common in Australia and Tasmania, for our own climate is quite suitable for them. The absence of Polynesian forms is not so remarkable as they belong chiefly to more tropical

genera, and the members of the genus *Coriphilus* are said to live only on bananas.

That we should have two cuckoos which migrate regularly to other countries, each more than a thousand miles distant, is a fact that deserves special attention, for I know of no parallel case in any other part of the world, the distance across the Mediterranean being less than half that travelled over by our summer visitants. The phenomenon of a bird at a certain season of the year flying out to sea to an island more than a thousand miles distant is remarkable enough, but is rendered still more so in the case of the little shining cuckoo (*Chrysococcyx lucidus*), which is supposed to come from Australia, by there being no apparent necessity for it. For this bird migrates east and west, and not from a warmer to a colder climate, and two other closely allied species which inhabit Australia never leave the country at all. Even in the case of the long-tailed cuckoo (*Eudynamis taitiensis*) which comes to us from the equable climate of the South Sea Islands, we cannot suppose that its migrations are caused either by alteration of temperature or by want of food, and the question forces itself upon us—How could this habit have arisen? The only reasonable hypothesis is, I think, that at one time the different lands to and from which these birds fly were connected, or nearly so; that the distance between them gradually increased, and that the habit, so common amongst birds, of resorting each year to the same place to breed, was not lost but gradually merged into a regular migration. From this point of view the arrival of the shining cuckoo indicates a connection with Australia or perhaps New Guinea, while that of the long-tailed cuckoo indicates one with Polynesia, and it must be noticed that while the latter bird is identical with specimens from Polynesia, the former shows such differences in the colouring of the tail feathers from the birds inhabiting Australia that it is considered by many naturalists to be a distinct species. Another remarkable fact, that has been quite lately brought to light, is that the shining cuckoo of the Chatham Islands is not the same variety as that visiting New Zealand, but is almost, if not quite, identical with an Australian species (*C. plagosus*). This curious fact proves how strong must be the force of habit, for these birds in their migration to and from the Chatham Islands must pass over, or at least in sight of New Zealand, but instead of stopping, after a journey of 1,400 miles, they continue on for 450 miles more, until they reach the little island that they have selected as their home.

A more difficult fact to account for is the presence of different species of grass-bird (*Sphenœacus*) in both Australia and New Zealand, for this bird has such feeble powers of flight that it could not cross a river, and must almost of necessity have travelled by land. It must, however, be noticed that this

genus extends through the Indian Archipelago into India, and I have not been able yet to compare our grass-birds with those of Australia and the Archipelago so that I am not able to say what amount of difference there is between them. The genus *Keropia* has most affinity with South American birds, while *Graucalus melanops*, which is closely related to our *G. concinnus*, is said to extend from Australia into New Guinea.

In the order *Grallæ*, or Waders, we come to birds more widely spread than any others, some indeed being almost cosmopolitan, but even amongst these the isolated character of our fauna is still marked, for out of twenty-eight species, belonging to seventeen genera, eight species and two genera are found nowhere else. The most noticeable feature in this order is the existence of a curious genus of rails (*Ocydromus*) quite unable to fly. Of this genus we possess four species, one in the North and three in the South Island, while a fifth species is found in Lord Howe Island, and a sixth in New Caledonia. *Notornis*, although somewhat like the pukeko (*Porphyrio melanotus*) in the bill, has the feeble wings, thick legs, and short toes of *Tribonyx mortierii* of Tasmania and Australia. Of our other rails two (*R. pectoralis* and *O. tabuensis*) are spread over Australia and Polynesia, while another (*O. affinis*) although not found elsewhere is closely related to a species from Australia (*O. palustris*). In the godwit (*Limosa uropygialis*) we have another migratory bird that probably comes from Polynesia, but as it is also found in Australia we cannot feel any certainty about it. New Zealand also displays the peculiarity of being the only country in the world inhabited by two species of stilt-plover (*Himantopus*) one of which (*H. novæ-zealandiæ*) is found nowhere else. This is probably owing to the length of time that New Zealand has been isolated, and to its having had during the whole of the period a stilt-plover on it, which gradually changed until it attained that remarkable jet black plumage which is so different from any other species, while the later colonist from Australia (*H. leucocephalus*) displays the colour usual to the genus. This view is rendered the more probable by the fact that the young of the black stilt-plover have the same pied plumage that is exhibited by the adults of those species from one of which I suppose it to have been derived.

In the crook-bill (*Anarhynchus frontalis*) we have another curious anomaly which as yet has received no explanation; and it must also be noticed that Cape Horn, the Cape of Good Hope, Australia, and New Zealand, each possess a black oyster-catcher (*Hæmatopus*), which are considered specifically distinct.

Among the herons the only very remarkable fact is the occurrence of the little bittern (*Ardea pusilla*), a bird found only in Australia and Natal. Our snipe (*G. pusilla*) very much resembles in plumage *G. stricklandi* from Tierra del Fuego, but it has a shorter bill.

Among the web-footed birds, the first thing that claims our attention is the oceanic family of the petrels (*Procellaridæ*), for although by no means peculiar to New Zealand,* the great number of species in the southern oceans, in comparison with the small number in the northern, is very noticeable. The northern and tropical species have all closely allied forms in the southern hemisphere, while many of the southern petrels, such as *Ossifraga*, *Halodroma*, *Majaqueus*, *Pterodroma*, *Daption*, and *Prion* have no representatives in the northern seas. This leads to the inference that the northern species have been derived from stray southern birds, and that the southern hemisphere has been the centre from which most oceanic birds have spread, while land birds, on the contrary, have spread chiefly from northern areas, and this leads to the further inference that the southern hemisphere has been for many ages more oceanic in character than the northern. The next most remarkable point is the great development of the cormorants, New Zealand possessing nine species, four of which are found nowhere else. No other country in the world possesses so many, and the phenomenon can only, I think, be accounted for in the same way as the numerous species of moa, that is, by the former existence of several small islands which have since been elevated to form the present New Zealand. The wide dispersion, however, of two of our cormorants is rather against this view, one (*G. carunculatus*) being found at the Crozet Islands and at Cape Horn, and the other (*G. carbo*) in Australia, China, and Europe. I must, however, remark that the identity of the first has not yet been perfectly established, and that the second, although very closely resembling specimens from Europe, shows at the same time some difference. It may also be useful to remark here that our gannet (*Dysporus serrator*), although a far better flying bird than the cormorants, is not found at the Chatham Islands, and Dr. Finsch informs me that it is undoubtedly different from the species (*D. capensis*) that occurs at the Cape of Good Hope. The occurrence of *G. brevirostris* and *G. melanoleucus* in New Zealand presents a parallel case to the two species of stilt-plover, with, however, this difference—that, judging from the colours of the young bird, it is probable that *G. melanoleucus* has been derived from *G. brevirostris*, owing to its having been isolated in Australia, and that its descendants have migrated back again to New Zealand.

Of the gulls we possess a species (*L. pomare*) which is found nowhere else, a peculiarity of which few countries can boast, but which can perhaps be accounted for by the fact that this gull only frequents fresh-water lakes, and seldom comes down to the sea. Our other gulls are widely spread, but it is a most remarkable fact, which at present appears to me to be quite inexplicable, that neither gulls nor cormorants occur in any of the Polynesian Islands.

Of ducks we possess nine species, four, or perhaps five of which are

* *Procellaria parkinsoni* is peculiar to New Zealand.

endemic; one, the blue duck (*H. malacorhynchus*), belonging to a curious genus found only in New Zealand, but related to a genus (*Malacorhynchus*) in Australia. The others are all found in Australia, one (*P. gibberifrons*) ranging through New Caledonia and the Indian Archipelago, and another, the common grey duck (*A. superciliosa*), spreading over Polynesia, as far north as the Sandwich Islands. The most remarkable circumstance connected with our ducks, is the presence of a species of *Fuligula*, a genus found neither in Australia nor Africa, but belonging properly to the northern parts of America, Europe, and Asia, although one species is found in South America. The occurrence, however, of a northern species (*F. cristata*) in the Pelew Islands points out to us perhaps the route along which the ancestors of our species travelled.

The Chatham Islands possess thirty-two species of birds, omitting the gulls, penguins, and petrels, of which six are found nowhere else. All the others are found in New Zealand, except the shining cuckoo (*C. plagosus*), which, as already stated, migrates to and from Australia. No genera, however, are peculiar to these islands, except perhaps a rail (*Rallus ? modestus*) which is evidently incapable of flight, and which will probably have to be placed in a genus by itself. This curious form must not, however, be regarded as a change produced by long isolation, but rather as an old form preserved from destruction by isolation. The most noticeable circumstance in the Chatham Island fauna is the absence of Raptores, with the exception of an occasional visit from the harrier (*Circus gouldi*), which does not however appear to inhabit the islands, or at any rate is exceedingly rare there.

The Auckland Islands possess twelve birds, three or four of which are endemic, the remainder all belonging to New Zealand. The most remarkable facts are the occurrence of a species of merganser (*Mergus australis*), a genus found only in high northern latitudes, and of a duck (*Nesonetta aucklandica*) with very short wings, belonging to a genus found nowhere else.

On Norfolk Island we know of twenty-six birds. Of these two (*Aplonis caledonicus* and *Platycercus novæ-zealandiæ*) are found in New Zealand and New Caledonia; five others are common to New Zealand and Australia; a species of *Nestor* (*N. productus*) used to inhabit Philip Island close by, and the remainder show an affinity to Australia.

Lord Howe Island possesses only six land birds, two of which (*Charadrius bicinctus* and *Ocydromus sylvestris*) show a connection with New Zealand, while the rest show an affinity to Australia.

A review of the facts disclosed by a study of the distribution of the Carinate birds shows that although the affinity is greater with Australia than with any other place, there is yet a decided leaning towards Polynesia, and when we remember that a large portion of Australia lies in the same latitude

as New Zealand, while the whole of Polynesia is far away to the north, I think the difference is not so great as might have been expected.* The distribution of the genus *Ocydromus* proves that land communication must once have existed between New Zealand, Lord Howe Island, and New Caledonia, but the absence of cockatoos, grass-paroquets, pigeons, night-jars, and finches, indicates that this connection did not extend to Australia. With the exception of *Sphenœacus*, which has very feeble powers of flight, all our Australian birds could have crossed over a strait of considerable width. The phenomena of the paroquets, starlings, and long-tailed cuckoo of Polynesia, being associated in New Zealand with the honey-eaters, grass-bird, and gold-cuckoo of Australia, indicate that New Zealand was connected with a tract of land intermediate to both, but perhaps not connected with either; at the same time the absence of the more tropical Polynesian birds is no evidence, that this tract of land did not extend into Polynesia, and in *Zosterops lateralis*, and *Dendrocygna eytoni*, both of which have appeared since Europeans came into the colony, we have positive evidence that our islands can even now be colonized from Australia by many kinds of birds, although 1,400 miles distant. It would also appear that this transfer of birds to New Zealand took place sufficiently long ago to allow of changes of generic value having taken place, while the Chatham and Auckland Islands have been isolated from New Zealand for a time sufficient only for changes of specific value.

REPTILIA.

The Reptiles of New Zealand are not numerous. We possess about eight species of lizards, four of which belong to widely spread genera of the family *Scincidæ*, but the species are all endemic. Three others belong to the *Geckoidæ*, and form a genus (*Naultinus*) which is found nowhere else. Of these one (*N. pacificus*) is said to be found in some of the Pacific Islands, but the other two are peculiar to New Zealand. Our eighth species, the curious tuatara (*Sphenodon punctatum*), which is now found only on a few rocky islets in the Bay of Plenty, and near Tory Channel in Cook Strait, is placed by Dr. Günther in a separate order from all other lizards on account of the affinity that it shows to the crocodiles. This remarkable form has no copulatory organs, and has uncinate processes on its ribs like birds. It has also nearly twice as many abdominal as true ribs, which protect the abdomen when being dragged along the ground, for, like the crocodile, the hind legs are too weak to support the hinder parts of the body. Dr. Günther also suggests that they may use them for locomotion, as snakes do. It is also remarkable

* The distribution of the *Megapodidæ* shows that Polynesia, Australia, the Indian Archipelago as far as the Strait of Lombok, North-west Borneo, and the Philippine Islands, were united before the spread of the Mammals.

that this animal, which lives in holes and only comes out during warm weather, should have the dorsal crest that is so characteristic of tree lizards.

I omit all reference to *Norbea? isolata*, supposed to come from White Island, in the Bay of Plenty, because its true locality is not sufficiently well established; if, however, another specimen should be obtained, it would be most important evidence in the present discussion.

But one species of lizard is found on the Chatham Islands, which is very variable, but which I consider to belong to the species *Mocoa zealandica*; it is, however, larger, and shows some slight differences in the shape of its cephalic shields.

A ringed sea-snake, probably *Platurus scutatus*, of Australia and Polynesia, is sometimes washed alive on to our coasts as far south as the mouth of the river Waikato, but it is not yet ascertained whether it is an inhabitant of our seas. A peculiar variety of *Pelamis bicolor*, which as yet has not been found in any other locality, has also been taken on our shores.

Amphibians.

The amphibious animals are worse represented even than the reptiles; one species of frog (*Liopelma hochstetteri*) being the only member of the class. This frog has now been found in three distinct localities, all, however, in the province of Auckland; these are the Cape Colville ranges from Coromandel to Puriri, the Huia on the north side of the Manukau harbour, and in the mountains behind Opotiki in the Bay of Plenty. It belongs to a genus not found elsewhere, but its nearest ally is *Telmatobius peruvianus* from Peru, and it should be remembered that the frogs of Australia are also allied to South American forms. It is evident that the absence of other Batrachians cannot be accounted for by the unsuitability of climate or want of food, for the common green frog of Australia (*Litoria aurea*), which has been introduced, has spread with great rapidity around both Auckland and Christchurch.

The evidence of the reptiles is, therefore, that New Zealand has had land communication with some of the Pacific Islands at a later date than with Australia, for in the first case there is no specific difference between forms found in both places, while in the latter the species are now quite distinct. Our frog proves a connection with South America at a period so remote that changes have since taken place of generic value.

Fish.

Up to the present time about 134 species of marine fish are known to inhabit the shores of New Zealand. Of these 51, or 37 per cent., are found nowhere else. Thirty-eight extend to the Australian and Tasmanian seas, but no further, six range to the Pacific Islands, five inhabit South America, four South Africa, and one Kerguelen Land and the Auckland Islands. There

are also four others that are common to both Australia and South America, five common to Australia and South Africa, two common to Australia and the Pacific Islands, and one common to Australia and the Auckland Islands. Thus the total number of our sea fishes found in Australia is fifty, in South America and the Cape of Good Hope nine each, three (*Prosopodasys cottoides*, *Trygon kuhlii*, and *Ostracion fornasini*) are not found nearer than the Indian Archipelago (the identification, however, of the latter is doubtful), and one (*Halargyreus johnsoni*) has been obtained at Madeira only. The remaining thirteen are widely ranging species. These 134 species have been distributed among 114 different genera, eleven of which are not found elsewhere. The connection with Australia is here, as might be expected, so well marked that I need not dwell upon it, but will proceed to examine the affinities of New Zealand to other countries. Our former connection with South America is indicated by *Mendosoma lineata*, *Notothenia cornucola*, *Merluccias gayi*, and *Genypterus blacodes*; with South Africa by *Trigla kumu*, *Gonorhynchus greyi*, and *Bdellostoma cirrhatum*, while the occurrence of *Gonorhynchus greyi* and *Congromuræna habentata* at St. Paul's shows that that little volcanic island was also probably connected. The occurrence in New Zealand of species belonging to the southern genera *Pseudorhombus*, *Bovichthys*, *Agriopus*, *Chilodactylus* and *Scorpis* points to the extension of a former antarctic continent, of which these islands formed a part, while *Acanthurus triostegus*, *Dascyllus aruanus*, *Chanos salmoneus*, *Peltorhamphus novæ-zealandiæ*, a species of stingaree allied to *Trygon thalassia*, and species of the genera *Labricthys* and *Trachelochismus*, show an affinity for the islands of the Pacific.

I have already remarked that three of our fishes are not found nearer than the Indian Archipelago, and it is probable that our species of *Torpedo* and *Doryichthys* came from that direction also. But a still more curious affinity to Japan is shown by the presence of the genera *Lotella* and *Ditrema*, and another little fish (*Calloptilum punctatum*) which is found at the mouth of the river Thames, and which has its nearest allies in the genus *Bregmaceros* from China and the Philippine Islands. *Gonorhynchus greyi* and *Clupea sagax* are also both found in Japan, but they occur in Australia as well. Our species of *Ditrema* differs from *D. læve* of Japan in having teeth on its palate, and a band of teeth in each jaw instead of a single row. *Platystethus cultratum*, from Norfolk Island, is also closely allied. This connection with China and Japan is, I consider, the chief point of interest in the distribution of our marine fish.

In the genus *Trypterygium*, which is found only in the Mediterranean, we have an anomaly which is parallel to the cases of *Fuligula* and *Mergus* among the birds, and as we proceed we shall find many other similar cases cropping up.

The fresh-water fish naturally supply more important evidence as to the former distribution of land than those inhabiting the sea. Of these, New Zealand possesses fifteen species, belonging to seven genera, of which six species, or 40 per cent., and one genus, are found nowhere else. That the percentage of the endemic fresh-water fish should be nearly the same as that of the marine fish is a remarkable and unexpected result, for the number of species of marine fish inhabiting New Zealand and found also in other countries depends partly on permanency of specific characters since New Zealand was isolated, and partly on the power possessed by fishes of migrating to us from other countries, while among the fresh-water fish the proportion depends entirely on permanency of specific characters; consequently, this permanency of specific characters must be greater in fresh-water than in salt-water fish, and this is the more remarkable as our fresh-water fish are far more variable, especially *Galaxias attenuatus* and *Eleotris gobioides,* than the marine, and *Galaxias attenuatus* being found both in South America and Tasmania must have had a longer specific existence than any of the others. It is therefore evident that a great amount of variability is not inconsistent with great specific longevity under certain conditions. The conditions in this case are, I believe, the absence of any large rapacious fish preying on the smaller variable ones, and thus tending to fix those varieties which are best adapted to elude the observation of the enemy. These conditions will soon no longer exist in our rivers on account of the introduction of the trout, and I should like to draw attention to the fact that descriptions and figures of all the varieties of fish occurring now in one or more of our rivers would be a most valuable contribution to science as material for future naturalists.

Of our fresh-water fish found beyond New Zealand, *Retropinna richardsoni* is found in the Chatham Islands; *Galaxias fasciatus* in both the Chatham and Auckland Islands; *Galaxias attenuatus* in the Chatham Islands, Tasmania, Patagonia, and South America; *Galaxias olidus* in Australia; *Anguilla aucklandii* in the Auckland Islands; *Anguilla australis* in the Auckland Islands, Tasmania and Timor; *Anguilla latirostris* in the Chatham Islands, Europe, Egypt, China, and the West Indies; *Geotria australis* in Australia; and *Geotria chilensis* in Western Australia and Chile. Thus four of our fresh-water fish are found in the Chatham Islands, and three in the Auckland Islands, which are all the fresh-water fish known to inhabit those places; three are found in Australia, two in Tasmania, two in South America, one in the Island of Timor, and one is spread from China to Europe and the West Indies. The Australian grayling also (*Prototroctes marœna*), although a distinct species, much resembles our own (*P. oxyrhynchus*); and another closely related genus (*Haplochiton*) is found in South America.

The genus *Eleotris* is widely spread in tropical countries. Its head quarters

are in the Indian Archipelago, and it ranges west to Madagascar, east to Mexico and the West Indies, north to Japan, and south to New Zealand, but is not found in Africa. The nearest ally of our species (*E. gobioides*) is *E. obscura* from Japan and China.

The evidence, therefore, to be derived from the fresh-water fish goes to prove that a close connection has existed between Australia, New Zealand, and South America. The fact of two species of the same genus of grayling being found in Australia and New Zealand respectively, while South America is inhabited by a closely allied but distinct genus, indicates either that our connection with Australia was later than with South America, or that in the old continent New Zealand and Australia were inhabited by one, and South America by another species of the same family. The fresh-water fish also prove that our connection with the Chatham and Auckland Islands was much later than with Australia. The distribution of *Anguilla latirostris*, which is not found nearer than China,* adds its testimony to that of *Lotella* and *Ditrema* of a former connection with that part of the world not by way of Australia, and we shall find that this remarkable connection with China and the Indian Archipelago, thus dimly shadowed out by the fishes, gets stronger and stronger as we review the invertebrate animals.

MOLLUSCA.

Of the New Zealand Mollusca about 460 species are now known, of which about one-half are found nowhere else. They show, as might be expected, a marked affinity with Australia, but are still very distinct. We miss *Olivella*, *Vanikoro*, *Eutropia*, *Perna*, *Trigonia*, and others; while *Mitra*, *Columbella*, *Marginella*, *Natica*, *Scala*, *Conus*, *Cypræa*, and *Cardium* are very feebly represented with us. On the other hand Australia does not possess *Buccinum*, and *Fusus*, *Imperator*, *Purpura*, *Turritella* and *Pecten* are much less developed than in New Zealand. As, however, the affinity is decided I shall here limit myself to pointing out our connection with other countries.

Of Cephalopoda we possess eleven species, only two of which are peculiar to New Zealand. *Onychoteuthis bartlingii*, *Ommastrephes sloani*, *Nautilus pompilius*, and *Argonauta nodosa*, are all found in the Indian Ocean, and the two last in the Pacific also, but none of them in Australia.

Of marine Gasteropods and Conchifera, omitting the marine air breathers, we have 330 species, about 160 of which are endemic. Of these *Cyclina kroyeri*, *Mytilus magellanicus*, and *Anomia alectus* are only found in South America, as also is the genus *Solenella*. *Chione mesodesma* is found at Valparaiso and the Philippine Islands, *Barbatia pusilla* in Peru and Australia,

* Dr. Gunther has lately described *A. obscura*, a closely allied species, from the Fiji Islands.

Myodora ovata in the Philippines and Australia, *Mytilus smaragdinus* and *Anomia cytæum* in China; while we also have a small *Cypræa* which appears to me to differ from *C. punctata*, from the Philippines, only in the absence of red spots. *Bankivia varians* is found in South Africa and Tasmania. Our common pipi (*Chione stutchburyi*) is found in Kerguelen Land, while *Ranella vexillum*, which is also found in Tasmania, is closely allied to *R. argus* from the Cape of Good Hope, and to *R. proditor* from St. Paul Island. The genera *Phorus*, *Rotella*, and *Calyptræa* are found in the Philippine Islands and China, but not in Australia. The genus *Lyonsia*, of which we possess one species, extends from Europe and India to the Philippine Islands and Borneo, and is also found in Peru and the West Indies. A few of our shells are almost cosmopolitan, as *Lucina divaricata*, *Saxicava arctica*, *Crypta unguiformis*, and *Lima squamosa*; while *Nucula margaritacea* inhabits Europe. *Dosinia subrosea* is said to have been found in the Persian Gulf, and the genus *Solemya* is found only in Australia and the Mediterranean. While, therefore, our marine shells show a decided affinity to Australia, they also show a slight connection with South Africa, Kerguelen Land, St. Paul's, and South America, and point more decidedly to a connection with the Philippine Islands and China.

Of land and fresh-water shells, including the marine air-breathers, we possess 114 species, of which 97 are not found elsewhere. These show many striking and important facts in distribution. Three only, *Helix subrugata*, *H. sydneyensis*, and *H. rapida* are found in Australia, and of these the second is so like *H. cellaria*, of Europe, that it has only lately been distinguished from it by Dr. Cox, and is also closely allied to *H. glaberrima* from the Solomon Islands. *Helix rapida* is also found at Erromanga, one of the New Hebrides. *Helix coniformis** inhabits the Louisade Islands, *H. radiaria* the Solomon Islands, and *H. vitrea* the Admiralty Islands. *Cassidula mustelina* is found at Singapore and Pulo-penang, and *Amphibola avellana* in New Caledonia. But the distribution of some of the genera is more important even than that of the species. *Nanina* spreads from India to China, the Philippines, Indian Archipelago, and Polynesia, and is also found in Madagascar and the Mauritius, but not in Australia. *Amphibola* extends over Australia and Polynesia to Burmah. *Lymnæa* extends from Europe to India, China and Java, and is also found in North America but not in Australia. *Assiminea* is found in England, India, Celebes, Molucca Islands, and the Navigator and Friendly Islands, but not in Australia. The family *Ancylinæ*, or fresh-water limpets, of which we possess two species, is found

* I am indebted to His Honour T. B. Gillies for the information that *H. coniformis*, *H. radiaria*, *H. subrugata*, and *H. vitrea* inhabit New Zealand. Mr. Gillies collected the specimens in the northern portion of the province of Auckland, and they were determined by Prof. Macalister, of Trinity College, Dublin.

only in North and South America, Europe, and Madeira; and our common slug (*Milax antipodarum*) belongs to a genus found only in Europe and the Island of Teneriffe. *Testacella*, of which we also possess a species, is only found in Europe and Teneriffe.

Our former connection with Australia, however, is shown in the family of bitentaculate slugs (*Janellidæ*), a family which is found only in Australia and New Zealand, and also in the marine air-breathing limpets (*Siphonaria*), three of our species being found in Australia and Tasmania.

The land and fresh-water univalves therefore show a stronger affinity to Polynesia and the Philippine Islands, by way of New Caledonia, the New Hebrides, Solomon Islands and the Indian Archipelago, than they do to Australia, although the distribution of the genus *Janella* shows that land communication once existed with Australia also. To South Africa and South America they exhibit no special affinity. Like the birds and fishes they also show a slight anomalous affinity to Europe without any intermediate steps.

From the Chatham Islands eighty-two species of Molluscs are known, of which nine appear to be peculiar to those islands; the rest are all found in New Zealand, including *Janella bitentaculata* and *Siphonaria scutulata.*

I know of two shells only from the Auckland Islands (*Patella illuminata* and *Vitrina zebra*), both of which are endemic.

MOLLUSCOIDA.

Of Brachiopods we possess eight or nine species, of which two only (*Kraussia lamarkiana* and *Magas cumingi*) are found in Australia, the latter being also reported to occur in China. The genus *Rhynchonella* is only known living in the arctic portions of North America and Japan, but this anomaly is not surprising when we remember that this genus existed during the Lower Silurian Period, but it is interesting as affording us the clue by which other similar anomalies may be explained.

The New Zealand *Tunicata* are as yet but little known. The genera *Ascidia*, *Boltenia*, and *Botryllus*, are only found in Europe and North America. *Doliolum denticulatum* is found at the Molucca Islands.

Of the *Polyzoa* I am acquainted with eighty-nine species, of which thirty-one have been found nowhere else as yet, but it is probable that their range is very imperfectly known. Twenty-three of our species are found in European seas, while the intervening tropical seas appear to be almost destitute of this form of life. The chief point of interest in our *Polyzoa* is the great development of the massive species of *Cellepora*, and of the coral-like family *Idmoneidæ*, which recall to mind the crag formation of England; indeed one of our species, *Hornera striata*, is found fossil in the crag; it is, however, also found fossil at Oraki, near Auckland, in beds of still older date. Considering how little

attention has been paid to our *Polyzoa*, the number of known species indicates a rich fauna, and, indeed, the entire class seems to be more abundant in the southern than in the opposite hemisphere, and, like the petrels, contains many forms quite unrepresented in the north.

INSECTA.

No New Zealand naturalist who has collected insects on however small a scale in Europe, can, I think, fail to be struck with the paucity in New Zealand, not only of species, but in some orders of individuals also. It is remarkable that in this country, whose indigenous warm-blooded animals are limited to birds and bats, on entering the bush instead of finding the masses of decaying wood and leaves swarming with life, we find hardly a living creature,* while at the same time we are attacked by myriads of blood-thirsty mosquitos (*Culex acer*). It would certainly seem that abundance of food does not produce abundance of individuals in some orders (e.g. *Coleoptera*), neither does an absolute dearth of food in the *imago* state prevent the increase of individuals in others (e.g. *Diptera*). The swarms of sand-flies (*Simulium cæcutiens*), also, that greet us on the coast, from the North Cape to the Bluff, where could they possibly have found food before the advent of man? Where indeed do they find it now in sufficient quantities?

Of beetles about 200 species inhabiting the land are described, the whole of which, I believe, are found nowhere else. These species are distributed into about 110 genera, of which about thirty-five are peculiar to New Zealand. A remarkable contrast to this is shown in the water-beetles, of which four only are known, two (*Cybister hookeri* and *Colymbetes rufimanus*) being, I believe, endemic, and the other two (*Colymbetes notatus* and *Gyrinus natator*) being found in Britain. The genera best represented are *Elater* with twelve, *Feronia* with eight, *Mecodema* with nine, *Xylotoles* with seven, *Cincidela* with six, *Anchomenus* and *Maoria* with five each, and *Coptoma* with four species. Few beetles can be called abundant, the little green species (*Pyronota festiva*) so destructive to our fruit trees, and a small brown species (*Colaspis brunnea*), common on the manuka (*Leptospermum*) in December and January, are, perhaps, the only two that deserve the name, although many can be called common. The beetles as a whole are, according to Mr. Pascoe, most closely allied to those of Australia.

The *Hymenoptera* are very poorly represented, about eighteen species only being as yet known. All are, I believe, endemic. Most of the genera are widely spread, but *Orectognathus*, and *Dasycolletes*, are peculiar to New Zealand. The poorness of our fauna in this order cannot be owing to

* My experience in this respect in New Zealand is very different to that of Mr. Wallace in Singapore and Borneo, but similar to his in Celebes and Ceram.

unsuitableness of climate, for the honey-bee (*Apis mellifica*) which was introduced about thirty years ago, has spread over both Islands.*

The *Diptera* are more numerous than the *Hymenoptera*, sixty species being known. This is just opposite to what obtains in most countries, including Australia and South America. Of these *Tipula senex* is found in Australia; *Musca taitensis* in Polynesia; and *Musca læmica* in both Australia and Polynesia. Although most nearly allied to Australia, our dipterous fauna must have been derived from other localities as well, for the genus *Diphysa* occurs only in Mexico and Brazil; *Actina* in Europe; *Cœnosia* and *Sapromyza* in Europe and North America; and *Opomyza* in Europe and the Mauritius. No genus is endemic. Of the earwigs we possess one endemic species (*Forficula littorea*), found only near the sea shore.

Of the *Lepidoptera* I know hardly anything, and prefer waiting until Mr. Fereday has published his promised descriptions of the species, before examining their bearing on the present subject. But one fact stands out prominently, viz., that out of more than three hundred species, only eight belong to the butterfly section (Fereday, *Trans.* N.Z. Inst. IV., p. 217), and of these several are world-wide stragglers.

Of *Neuroptera* about fifteen species are known. Of these, *Perla opposita* is found in Tasmania; and our representative of the white ants (*Calotermes insularis*) in Australia. This order appears to have more affinity with Tasmania than with Australia, and it is remarkable that the wide spread genus *Perla*, which is found throughout North and South America, and from Europe through India to China and Japan, is also found in New Zealand and Tasmania, but not in Australia. *Leptocerus* has also the same range, with the exception of not being known in China and Japan. *Hermes* extends from India to China and Java; it is also found in tropical Africa and South America, but not in Australia nor Tasmania. *Palingenia* is found in Europe, India, North Africa, and North and South America; while *Philanisus* is peculiar to New Zealand. The *Heteroptera* are remarkable for their fragmentary character, and wide distribution. The thirteen known species belong to thirteen different genera, and nine families. *Arma schellembergii* is found in Australia and the Philippine Islands; *Cermatulus nasalis* in Australia and Tasmania; *Platycoris immarginatus* and *Rhaphigaster amoyti* in Australia; *Lygans pacificus* in Australia, Tasmania, and India; and *Nysius zealandicus* in Tasmania; thus leaving not more than seven endemic species, three of which have not yet been properly examined, and may therefore be found to be identical with species inhabiting other countries. One of the endemic species (*Rhopalimorpha obscura*), however, belongs to a genus found nowhere else.

---

* Mr. W. T. L. Travers informs me that the honey-bee was introduced into Nelson in 1842, and that wild bees were common in 1850.

In strong contrast to this stand the *Homoptera,* which include nineteen species, all endemic, and belonging to three genera only; *Cicada* having twelve, and *Cixius* seven species.

The number of species of *Orthoptera* I do not know, but in comparison with other orders it is well represented by both winged and wingless members, and the genera, as a rule, contain several species.

Whilst, therefore, the insect fauna as a whole shows its greatest affinity towards Australia it also exhibits a connection with other countries, more especially China and Europe. But the most remarkable fact is the great difference shown in this respect by the different orders. Whilst the *Diptera, Neuroptera, Homoptera* and *Orthoptera* present the appearance, in part at least, of an old fauna, the *Heteroptera* are nearly all stragglers, and this strongly suggests the inference that at the time of the spreading of the former orders the *Heteroptera* were not in existence. The same thing is seen in the difference between the moths and the butterflies, suggesting also that the latter were developed at a later period than the former, and there can be no doubt but that when our insects are better known a careful comparison of them with similar faunas of other countries will afford a most instructive lesson.

With the exception of the Indian (*Blatta orientalis*) and American (*B. americana*) cockroaches, neither of which are common, the flea (*Pulex irritans*), the bed-bug (*Cimex lectularius*), several *Aphides,* the slug-worm (*Tenthredo cerasi*), and the house-fly (*Musca domestica*), I am not aware of any insect that has been introduced unintentionally by man during the progress of colonization, for the ring-legged mosquito, which is supposed in Auckland to have been introduced by the troops from India, belongs to a species (*Culex argyropus*) not found elsewhere, and was sent home by Dr. Sinclair before the troops arrived. The only exceptions may perhaps be the black field-cricket, which, although inhabiting fields with us, and but rarely entering houses, appears to be identical with the house-cricket of Europe (*Acheta domestica*) and to have spread quite lately; and also a small dark-brown beetle belonging to the genus *Elater,* which is abundant in Auckland, but, to the best of my knowledge, is not found more than twenty miles out of that town.

Myriapoda.

Of Centipedes nine or ten species are now known, all of which are endemic. The genus *Lithobius* extends from North America, Europe, and North Africa to Singapore, but is not found in Australia. *Henicops* is found only in Chile and Tasmania, *Cryptops* only in North America and England, while *Cermatia* and *Cormocephalus* have wider ranges, and are both found in Australia.

ARACHNIDA.

Of Spiders we have about 100 species, but my knowledge of them is very limited. Mr. Pickard-Cambridge, in a letter to me remarks, "all the spiders you now send (from the Auckland province), except one or two, are strikingly European in appearance, nothing tropical-looking among them." Perhaps the most remarkable fact is the occurrence in the Chatham Islands of a species of water-spider (*Argyroneta*) of which only one other species, inhabiting Europe, is known. Spiders are very numerous in New Zealand, owing no doubt to the abundance of *Diptera*, on which order they chiefly prey.

CRUSTACEA.

Of Crustaceans 106 species have been described as coming from New Zealand, but my knowledge of this class also is at present very limited. Professor Dana has remarked that New Zealand has a greater resemblance to Great Britain in its Crustacea than to any other part of the world; but our common salt-water crayfish (*Palinurus lalandii*) is found at the Cape of Good Hope and the Island of St. Paul.

ANNELIDA.

Our marine Annelids have up to the present been almost entirely neglected. Of terrestrial forms we have two species of earthworm (*Lumbricus*) and a member of the peculiar genus *Peripatus*, found only in South America, the Cape of Good Hope, and the West Indies.

SCOLECIDA.

The most remarkable fact in this class is the occurrence of two or three species of land Planarians, the so-called "land-leeches," one or two of which belong to the genus *Bipalium*, found only in India, China, and Japan.

ECHINODERMATA.

Of Echinoderms we have seventeen species of star-fish, eight sea-urchins, and eight holothurians. Of these twelve star-fish, six sea-urchins and all the holothurians appear to be endemic. Of the others *Ophionereis fasciatus* is found at the Chatham Islands, *Pentagonaster pulchellus* at the Chatham Islands and in China, *Othilia luzonica* in the Philippine Islands and Vera Cruz, while we also possess species apparently identical with *Astropecten armatus* of South America, and *Henricia oculata* of Europe. It is worthy of special remark that although Australia possesses several species of *Pentagonaster*, the Chinese species is not found there, so that it must have migrated to us direct, and not have come *viâ* Australia. We also possess a species of *Pteraster*, a genus found only in South Africa and Northern Seas. Of the sea-urchins, *Cidaris tubaria*, and *Echinobrissus recens* are both found in Australia, but the latter appears to be very rare in New Zealand, as I have only seen one specimen, which is in the Colonial Museum.

Cœlenterata and Protozoa.

Of these very little is known. Our seven species of corals are all peculiar, as also appear to be many species of Sertularians and sponges, but I know of no facts among these lower animals that will help out the present investigation except in the case of *Cryptolaria*, a genus belonging to the family *Sertularidæ*, and consisting of two species, one of which is found in New Zealand and the other in Madeira.

Summary.

If now we review the evidence adduced, and select the more important points we find in the distribution of the Struthious birds, the frogs, fresh-water fishes, several shells (such as *Cyclina kroyeri*, *Mytilus magellanicus*, *Anomia alecto*, *Barbatia pusilla*, *Chione stutchburyi*, and *Ranella vexillum*), in the genus *Hemicops* among the Centipedes, and *Peripatus* among the Annelids, evidence of a former great extension of land in the Southern Hemisphere, for these cases cannot all be accounted for by drifting icebergs. With the exception of the shells and two fresh-water fishes no species however is common to New Zealand and South America on the one hand, nor to New Zealand and South Africa on the other, for I omit from consideration the species of marine fish, as they might perhaps have crossed at a later date. In the frogs the genera, and in the birds the families, are different. This perhaps indicates a very long interval since the separation of these countries took place, but differentiation of form, even in closely allied species, is evidently a very fallacious guide in judging of lapse of time, and a surer one is afforded us in the absence of Mammalia from New Zealand, for it is evident that if the Marsupials that now inhabit Australia, or the placental Mammals that inhabit South America, had been in existence at the time of the distribution of the Struthious birds some members would have found their way to New Zealand, and would have remained upon it with the Moas. This antarctic continental period must therefore have preceded the spread of the Mammalia into the Southern Hemisphere. Besides this continental period we have evidence in *Eudynamis taitiensis*, *Naultinus pacificus*, *Amphibola avellana*, *Musca taitensis*, and in the genera *Ocydromus* and *Nestor*, of a Polynesian continent quite unconnected with Australia, but including Lord Howe Island, Norfolk Island, and New Caledonia, while by *Helix coniformis*, *H. rapida*, *H. radiaria* and *H. vitrea*, we can prove a close connection with the New Hebrides, Solomon Islands, Louisade Archipelago, and the Admiralty Islands. By *Nanina* among land shells, and *Assiminea* among fresh-water shells, we prove a connection also with the Navigator and Friendly Islands, and these genera take us north through the Molucca Islands, Celebes, Borneo and the Philippines, to China, where we again come across many New Zealand species and genera. The

most important are *Ditrema*, *Torpedo*, and *Anguilla latirostris* among fishes; *Mytilus smaragdinus*, *Phorus*, *Rotella*, *Calyptræa*, *Cassidula mustilina*, *Lymnæa*, and *Rhynchonella* among shells; *Perla* and *Hermes* among insects; *Lithobius* among centipedes; *Bipalium* among the Scolecida, and *Pentagonaster pulchellus* and *Othilia luzonica* among the star-fish; none of these, it must be remembered, being found in Australia. The absence of Mammalia, however, in New Zealand shows that this line of communication was never continuous land, but the absence from Australia of the forms that I have mentioned shows that the connection along the whole line was closer at every point than it was with that continent, and this leads to the further conclusion that this line of communication existed at a later date than the connection of New Zealand with Australia.

The close relationship of the Chatham and Auckland Islands in all their natural productions to those of New Zealand, and the far greater difference between New Zealand and the islands more to the north, as well as the large number of species of moa lately inhabiting these islands, shows that another and smaller continent, or perhaps a large island, existed at a still later period, but has since subsided, and this must bring us nearly to the recent period, or the difference between New Zealand and the Chatham Islands would be greater.

The geographical distribution, therefore, of the New Zealand fauna points to the following conclusions:—

1. A continental period, during which South America, New Zealand, Australia, and South Africa were all connected, although it is not necessary that all should have been connected at the same time, but New Zealand must have been isolated from all before the spread of the Mammals, and from that time to the present it has never been completely submerged. This continent was inhabited by Struthious birds, and by *Hymenolaimus*, *Notornis*, *Hinulia*, *Mocoa*, *Galaxias*, *Prototroctes*, *Liopelma*, *Janella*, *Amphibola*, *Hemicops*, and *Peripatus*, and further to the north by *Megapodius*; and probably also by many forms peculiar to New Zealand, such as *Stringops*, *Keropia*, *Xenicus*, *Heteralocha*, *Anarhynchus*, *Naultinus*, etc. Of course in mentioning these names I do not mean that all the forms were the same then as now, but that the ancestors of these genera lived on the old antarctic continent.

2. Subsidence followed, and the evidence then points to a second continent stretching from New Zealand to Lord Howe Island and New Caledonia, and extending for an unknown distance into Polynesia, but certainly not so far as the Sandwich Islands. The fact of Mammals being found in the New Hebrides, Solomon Islands, and New Ireland, shows that between New Caledonia and the New Hebrides a narrow strait must have existed, cutting off land communication, but these were connected with China either direct or

by a chain of islands. This second continent received from the north those forms already enumerated together probably with *Sphenœacus*, the rails, and the starlings; at the same time it received from Australia the honey-eaters, *Certhiparus*, *Gerygone*, *Petroica*, *Rhipidura* and others, and from that time to the present has been occasionally receiving additional birds. It will also be noticed that very few of the birds of the middle palæotropical region came down this line of communication, no pheasants, woodpeckers, grackles nor finches, while Australia in its wood-swallows (*Artamus*), pittas, quails, and numerous finches, shows now some affinity to this region. This can be best explained by supposing that the New Zealand line of communication was broken up before these birds came into existence, and that further changes have since taken place in the lines of easiest communication; indeed, the fact of such forms as the elephant, tiger, and bear being found in Sumatra and Borneo; Marsupials in Celebes, the Moluccas, Solomon Islands, and New Hebrides; and the presence of an emu in New Guinea, and a cassowary in Australia, prove that changes in the distribution of land have since taken place, but it is foreign to the object of this paper to speculate on these here. This second continent was also inhabited by most of the orders of insects, although perhaps not in great abundance, but *Heteroptera* and the butterfly section of the *Lepidoptera* were absent.

3. Subsidence again followed, and New Zealand was reduced for a long time to a number of islands, upon many of which the moa lived. This was followed by—

4. Elevation; these islands were connected and a large island existed disconnected from Polynesia. This was once more followed by—

5. Subsidence, and the geography of this part of the world assumed somewhat of its present form.

Geological Evidence.

Such are, I think, the deductions that may be fairly drawn from a study of our fauna. It remains now to examine the geological and palæontological evidence and see whether it agrees with that derived from zoology, and then try to fix with as much accuracy as possible the dates of the principal movements of the earth's surface which have gradually led to the present state of the New Zealand fauna.

Hardly anything is yet known of the palæozoic rocks of New Zealand. The earliest fossil shells described are almost identical with those living in Europe during the triassic period, but the only known plant is *Dammara australis* (Hochstetter's "New Zealand," p. 57), a genus still living in New Zealand, but also found in Australia, New Caledonia, New Hebrides, Fiji, and the Indian Archipelago.

An interval then occurs, and the next formation probably belongs to the jurassic period. In this we find *Belemnites aucklandicus,* which can hardly be distinguished from *B. canaliculatus,* and *Astarte wollumbillaensis.* The ferns, too, found so plentifully near Port Waikato, in the Clent hills, at the Mataura, and at Waikawa harbour, are considered by Professor McCoy to be identical with Australian ferns from the same formation. At the close of this period movements on an extensive scale commenced in New Zealand, the land was upheaved, and an extensive mountain chain formed. A long blank now occurs in our geological record (see Geo. Reports, 1872, p. 105), the next formation belonging to quite the uppermost part of the secondary epoch, later I believe than the white chalk of England. In it we find remains of dicotyledonous plants and large Saurians belonging to the genera *Crocodilus?* and *Plesiosaurus.* Here also we find three fossil shells (*Dentalium majus, Lucina americana* and *Cucullæa alta*), similar to those found in South America, one of which, *Lucina americana,* is found in the lower cretaceous rocks of Tierra del Fuego, and the other two in the miocene formations of Patagonia and Chile; thus showing that during this blank in our geological record an intimate connection had existed between New Zealand and South America. The disposition, however, of these beds shows that the New Zealand Alps were not submerged. A long interval now follows, during which New Zealand was again upheaved, and the next rocks that we find are of upper eocene date (Geo. Rep., 1872, p. 182). From that time until the close of the miocene period New Zealand was greatly depressed, and divided into several islands, but at the close of the miocene period it was once more upheaved. During this period we find several South American miocene shells not met with in the older formation, as well as several Australian ones. During the newer pliocene period it again subsided, and the Wanganui beds were deposited. From that time I can see no evidence of the land having ever stood at a higher level than it does at present, but as the later changes in the physical geography of New Zealand have a most important bearing on the present condition of its fauna, beyond the scope of my present inquiry, I propose treating the subject in a separate paper.* The geological evidence is, therefore, that since the jurassic period there have been three principal upheavals in New Zealand, in the lower cretaceous, lower eocene, and older pliocene periods respectively, and that these were divided by two insular periods, viz., during the upper secondary (Danien), and from the commencement of the upper eocene to the close of the miocene, thus agreeing completely with the zoological evidence.

The dates assigned by the geological evidence also agree well with those derived from zoology. We have seen that it is necessary to suppose that the first great antarctic continental period was anterior to the date of the spread

* *Vide post,* "On the Date of the last Great Glacier Period in New Zealand."

of the Mammals southwards. Now a few Marsupials are known in the triassic period, but it is quite possible either that they spread very slowly, or that barriers existed that prevented any southward migration. In the eocene period, however, some placental Mammals were in existence, although Marsupials, not of Australian types however, still formed in Europe the principal mammalian life; and if the supposed barriers to a southward migration were still in existence, we know, from what happened in the Northern Hemisphere, that the whole, or nearly the whole, of the Marsupials would have been exterminated. The Marsupials, therefore, must have migrated south not later than the eocene period, and as we know that our connection with Australia and South America must have been before that migration, it follows that the first, or lower cretaceous period of upheaval, must have been the time of the antarctic continent. This is rendered still more probable by the fact that our jurassic fossils show a connection with Australia only, while our upper secondary fossils show for the first time a relation to South America. The fact, too, of the cretaceo-oolitic rocks of Tierra del Fuego having been largely disturbed, metamorphosed, and broken through by dykes of green-stone, shows that extensive elevatory movements have taken place there, also, since they were deposited. It is therefore to the lower cretaceous period that we must probably look for the time of the dispersion of the Struthious birds. With regard to the date of the second, or Polynesian continental period, the only zoological evidence we have is that it probably preceded the wide dispersion of the *Hemiptera*, and the butterfly section of the *Lepidoptera*. This, therefore, could not have been later than the eocene, for a fossil butterfly (*Vanessa pluto*) has been found in the lower miocene deposits of Radaboj in Croatia, and fossil *Heteroptera* in the miocene beds of Œningen in Switzerland. The elevation during the lower eocene period was therefore probably the one which formed the continent that I have described as including New Caledonia and some of the Pacific Islands. At this period probably Northern Australia was submerged, and the southern portions of Australia and Tasmania formed one large island, while New Guinea, including the Solomon Islands and New Hebrides on the south, and the Molucca Islands on the north, formed another large island, divided from the New Zealand island, or continent, by the straits between New Caledonia and the New Hebrides.

This was the time of the migration from China southwards, and it is worthy of notice that at the same time a large ocean existed from southern Europe to China, in which the nummulitic limestone was being deposited. Would it be too bold to speculate that it was along the shores of this ocean that those fish, crustaceans, and shells migrated, which are now found in the North Atlantic or Mediterranean on the one hand, and in China or Japan on the other, but not on the southern shores of Asia; and that the anomalous

distribution of European forms of fish, shells, etc., in New Zealand may be traced to the same route? This same period of sea communication between Europe and Japan will also probably have been the time of the land connection that once existed between India, Madagascar, and Africa (the Lemuria of Dr. Sclater), as proved by the recent fresh-water fish, and birds, as well as by the miocene Mammalia,* and to this period we may also refer the origin of the curious affinity between some of the birds of Celebes and Africa. The long insular period during the upper eocene and miocene times will, therefore, be the period of specific change in the moas, while the older pliocene upheaval will be the time of the mingling of the various species in New Zealand, and the peopling of the Chatham and Auckland Islands. The newer pliocene was the time when the two islands of New Zealand were divided, and also the period when the Chatham and Auckland Islands were separated from them, but the latter occurrence probably preceded the former by a long interval.

Such appears to me to be the hypothesis most capable of accounting for the present fauna of New Zealand.

The objection, however, may be fairly raised that, if it is true, evidence of its truth ought to be also found in the flora of the country, which is not the case. I fully acknowledge the force of this argument, but think that some slight evidence can be found in the phænogamic flora. The distribution of *Eucalyptus* for instance, is somewhat parallel to that of the Marsupials, and can be only explained in the same way. *Stilbocarpa polaris* has its nearest allies in China and the Himalaya Mountains; while the distribution of *Metrosideros*, *Ligusticum*, *Angelica*, and perhaps *Veronica*, implies a connection between New Zealand and Asia not by way of Australia. This connection is obscured by the great preponderance of Australian and South American forms, but still furnishes an indistinct copy of the bolder outline sketched out by the fauna. This is owing to the wider distribution of genera among plants than among animals, and to me it appears to prove that the flora of a country, as a whole, is of a more ancient date than its fauna. Among the cryptogamic plants no trace of this outline can be discerned, as also is the case with the lower classes of the animal kingdom, owing to the genera having been, so to say, universally spread before the last migration from Asia took place.

That the façies of a fauna and flora should date back from so long a period as I suppose, is certainly at variance with ordinarily received opinion, but from a study of the fauna and geology of New Zealand I do not see how we can escape from the conclusions that I have arrived at. I am well aware,

* Professor Huxley thinks ("Quar. Jour. Geo. Soc." 1870. Ann. Address, p. 56.) that the land communication between India and South Africa was caused by the upheaval of the nummulitic sea, but it seems to me more probable that the land communication was by the shores of that sea.

however, that much more has to be done in the geology and natural history, not only of our own islands, but also of the surrounding countries, before they can be considered as satisfactorily proved; but I think that it will be easier afterwards to prove this hypothesis, or to disprove it and point out a more correct one, than it would be to detect it if the discussion had been postponed to a future period, when the more salient points will probably be obscured by the mass of facts which will then have accumulated. Such at least is my hope, but whether I am mistaken or not I leave others to judge.

ART. XXVII.—*On the New Zealand Sertularians.*

By Capt. F. W. HUTTON, C.M.Z.S.

[*Read before the Wellington Philosophical Society, 20th October,* 1872.]

Family SERTULARIDÆ.

HYDROSOMA fixed, plant-like, horny, variously branched; polypites hydraform, sessile, protected by hydrothecæ, and connected by a cænosarc, never terminal; reproductive organs contained in horny deciduous cells scattered over the hydrosoma.

Genus *Sertularia*, Linnæus.

Hydrosoma variously branched; hydrothecæ alternate or paired, biserial, urceolate.

SERTULARIA JOHNSTONI.

Sertularia johnstoni, Gray, "Dieff. N.Z.," II., p. 294.

Hydrosoma lax, spreading, dichotomously or sub-pinnately branched, pale brown. Hydrothecæ distant, short, alternate; aperture with two blunt teeth. Ovarian cells ovate, transversely wrinkled, truncated at the top.

Lyall Bay. (F.W.H.) Common.

SERTULARIA SUB-PINNATA, sp. nov.

Hydrosoma lax, erect, dichotomously or sub-pinnately branched, reddish brown. Hydrothecæ distant, alternate, ovate with two or three rather acute teeth. Ovarian cells — ?

Lyall Bay. (F.W.H.)

SERTULARIA DELICATULA. sp. nov.

Hydrosoma lax, slender, erect, dichotomously branched, pale yellowish brown. Hydrothecæ distant, alternate; aperture with two blunt teeth on

the outer side, and an acute recurved tooth on the inner side. Ovarian cells ovate, transversely wrinkled, with an acutely toothed crown.

Lyall Bay. (F.W.H.)

SERTULARIA MONILIFERA. sp. nov.

Hydrosoma strong, erect, dichotomously branched; pale brown. Hydrothecæ alternate, crowded, tubular, the upper half slightly recurved; arranged in several rows on the main stems, but in two rows on the branches; aperture entire, or with two obtuse teeth. Ovarian cells ovate, with strong moniliform cross ribs, and with an entire edged tubular crown.

Lyall Bay. (F.W.H.) On shells.

SERTULARIA SIMPLEX. sp. nov.

Hydrosoma short, simple or rarely branched, erect; pale yellowish brown. Hydrothecæ distant, alternate, ovate; aperture sinuated. Ovarian cells ovate, transversely wrinkled, with a toothed crown.

Lyall Bay. (F.W.H.)

SERTULARIA FUSIFORMIS. sp. nov.

Hydrosoma lax, simple or sparingly branched, rather large. Hydrothecæ alternate, rather close, long; aperture obliquely truncated, and with two rounded teeth on the outer side. Ovarian cells fusiform, large, smooth, pointed at the apex.

Lyall Bay. (F.W.H.) On Fuci. Common.

SERTULARIA BISPINOSA.

Dynamene bispinosa, Gray, "Dieff. N.Z." II., 294.

Hydrosoma long, lax, sparingly dichotomously branched, pale brown. Hydrothecæ opposite, tubular; aperture obliquely truncated, and with two strong teeth on the outside. Ovarian cells urceolate, smooth, with a small tooth on each side at the top.

Lyall Bay. (F.W.H.) On shells, etc., abundant.

SERTULARIA ABIETINOIDES.

Dynamene abietinoides, Gray, l.c. II., 294.

Hydrosoma erect, pinnately branched; pale brown. Hydrothecæ crowded, sub-opposite, tubular, slightly incurved; aperture surrounded with about five acute teeth. Ovarian cells urceolate, smooth, with a long blunt process on each side at the top.

Lyall Bay. (F.W.H.) Abundant.

Genus *Thuiaria*, Fleming.

Hydrosoma variously branched. Hydrothecæ biserial, adnate, or imbedded in the substance of the stem and branches.

THUIARIA ARTICULATA.

S. articulata, Pall., *Elench.* 137? *T. articulata*, Johnst., "Brit. Zooph.," p. 84?

Hydrosoma thick, erect, pinnately branched; branches alternate; pale brown. Hydrothecæ alternate, ovato-tubular, slightly curved; aperture truncated, entire. Ovarian cells — ? not seen.

Lyall Bay. (F.W.H.) A single specimen only.

THUIARIA ZEALANDICA.

T. zealandica, Gray, l.c., II. 214.

"Pale brown, erect, branches oppositely pinnate. Hydrothecæ small, exactly opposite, triangular; aperture truncated, with a small central tooth."

New Zealand. (Dr. Sinclair.) I have seen no specimens.

Genus *Antennularia*, Lamark.

Hydrosoma variously branched; branches clothed with hair-like verticillate branchlets. Hydrothecæ small, sessile, campanulate, unilateral.

ANTENNULARIA ANTENNINA.

S. antennina, Linn., *Syst.* 1310. *A. antennina*, Johnst., "Brit. Zooph.," p. 86.

Hydrosoma strong, erect, sub-pinnately branched; branchlets numerous. Hydrothecæ with intermediate cellules. Ovarian cells — ?

Lyall Bay. (F.W.H.) A single specimen only.

Genus *Plumularia*, Lamark.

Hydrosoma simple or branched, the branches pinnate; hydrothecæ small, sessile, unilateral.

PLUMULARIA PENNATULA.

S. pennatula, Ell. & Sol., Zooph., 56. *P. pennatula*, Johnst., "Brit. Zooph.," p. 94.

Hydrosoma simple, or sparingly branched, formed by a single tube; branches alternately closely pinnate; brown or reddish-brown. Hydrothecæ approximated, seated in the axil of a long incurved spine; aperture unequally crenated. Ovarian cells large, sub-cylindrical, stalked, with numerous transverse strongly denticulated ribs, situated on the inner side of the branches.

Lyall Bay. (F.W.H.) Common.

PLUMULARIA BANKSII.

P. banksii, Gray, "Dieff. N.Z.," II., 294.

Hydrosoma irregularly branched, composed of several tubes; branches alternately closely pinnate; pinnæ leaning to one side; reddish-brown. Hydrothecæ approximated, seated in the axil of a double incurved spinous process; aperture with an obtuse tooth on each side. Ovarian cells —?

Lyall Bay. (F.W.H.) A single specimen only.

ART. XXVIII.—*Contributions to the Ichthyology of New Zealand.*

By Captain F. W. HUTTON, F.G.S., C.M.Z.S.

(With Illustrations.)

[*Read before the Wellington Philosophical Society, 28th August,* 1872.]

1.* *Oligorus gigas*, Owen. (Cat., p. 1.)

This fish is no doubt the same as *Sciæna gadoides* of Dr. Solander, *Perca prognathus* of G. R. Forster, and *Polyprion cernuum* of Richardson, in Dieffenbach's "New Zealand," II., 206. By the rule of priority, therefore, it should be called *Oligorus gadoides.*

4. *Scorpis hectori*, Hutton. (Cat., p. 4.) Pl. VII.

A fresh specimen of this fish, caught in the Bay of Plenty, having been brought to the Colonial Museum enables me to correct and add to my former description.

B. 6; D. $\frac{10}{19}$; A. $\frac{3}{8}$; V. $\frac{1}{5}$; P. 17; L. lat., 67; L. trans., 7/25.

Teeth on the vomer, palatine bones, and tongue; cleft of the mouth very oblique; maxillary much expanded and truncated at the end, extending to the vertical from the middle of the eye; sixth dorsal spine the longest, less than half the length of the head, second anal spine very strong; scales finely serrated; caudal forked.

Uniform rose pink, passing into pale grey on the body.

Total length of the specimen, $17\frac{1}{4}$ inches.

11. *Chilodactylus spectabilis*, Hutton. (Cat., p. 8.) Pl. VII.

A fresh specimen of this fish having been brought to the Colonial Museum, I am enabled to give a better description of it than that in the "Catalogue of New Zealand Fishes," which was drawn up from a specimen that had been preserved in carbolic acid and dried.

* The numbers refer to those in the "Cat. of Fishes of New Zealand." Geol. Dept., N.Z., 1872, the additional species being in large type.

D. $\frac{16\text{-}17}{25\text{-}26}$; A. $\frac{3}{9}$; V. $\frac{1}{5}$; L. lat., 56; L. trans., 5/14.

Length three and one-third times that of the head, or three times the height of the body; six simple pectoral rays projecting beyond the membrane; fifth the longest, reaching to the perpendicular from the fifteenth or sixteenth dorsal spine; the lower rays graduated; branched rays simply divided only; sixth and seventh dorsal spines nearly equal and longest; the third anal spine longer than the second; scales rugose; lips very thick and fleshy; opercles with small scales; nostrils large, close together, the anterior with an appendage behind.

Brownish orange, with traces of six transverse bands of darker; soft dorsal, anal, caudal, and tips of ventrals blackish; lips and throat grey; belly silvery.

Total length of the specimen 24 inches.

13a. MENDOSOMA LINEATA, Forst. C.M.

Pl. VII.

Sciæna lineata, Forst. *Latris lineata*, Rich., "Dieff. N.Z.," II., 209. *M. lineatum*, Gay, "Hist. Chile," Zool., II., 213; Günther, "Cat. Fishes in Brit. Mus." II., 85. *L. lineata*, Hector, "Cat. Col. Mus.," p. 83.

B. 6; D. $\frac{23}{25}$; A. $\frac{3}{19}$; P. 17; V. $\frac{1}{5}$; L. lat., 65; L. trans., 6/17.

Length four times that of the head, or three and a quarter times the height of the body; compressed; snout produced, going rather more than two and a half times into the length of the head; upper profile concave; interorbital space flat, one and a half times the diameter of the eye, which is one-fifth of the length of the head; top of the head above the eyes hollowed; lower jaw shorter; maxillary arched, with an obtuse angle on the superior margin; inter-maxillary with a swelling in the centre on the upper and outer margin; mouth very protractile; a few minute teeth on the centre of the upper jaw, none on the lower; cheeks, opercles, and top of the head, as far as the tip of the snout, covered with small scales; præoperculum and operculum entire, the upper margin of the latter sinuated; dorsal single, deeply notched, the sixth to the ninth spines nearly equal and longest, about one-third the length of the head, and equal to the anterior portions of the soft dorsal, and anal; anal spines moderate.

Above dark olivaceous grey, more or less marbled with blue; sides greenish silvery, with many thin olivaceous brown longitudinal stripes; belly greyish silvery; fins olivaceous.

This specimen, which was 14 inches in total length, was taken in Cook Strait, 1st August, 1872. Dr. Hector also obtained it in Milford Sound in 1863.

A drawing of the head is also given with the mouth protruded.

14. *Sebastes percoides*, Sol. (Cat., p. 9.) Pl. VIII.

15. *Scorpæna cruenta*, Sol. (Cat., p. 10.) Pl. VIII.

29. *Cyttus traversi*, Hutton. (Cat., p. 19.) Pl. IX.

Mr. W. Travers informs me that this fish was taken in a net in a tidal creek. When first caught it had a beautiful silvery appearance, and the filaments from the dorsal and ventral fins were very long, but have shrunk greatly since being put into spirits.

31a. NEPTOMENUS BILINEATUS. sp. nov. C.M.

Pl. VIII.

B 6; D 6 $|\frac{1}{38}$; A $\frac{2}{23}$; L. lat. 120?

Length three and three quarter times that of the head, which is equal to the height of the body; snout considerably longer than the diameter of the eye; posterior end of præoperculum straight, entire; operculum with an obtuse point over the shoulder. Scales small and deciduous; a second line, but without pores, runs below the lateral line from a little above the point of the operculum, and joins the lateral line at the end of the second dorsal. Pectorals pointed, not quite so long as the head, and not quite reaching to the vent.

Back and sides pale violet, with minute black dots; belly silvery; tip of both dorsals and inside the pectorals blackish.

Wellington harbour, November, 1872.

This species approaches *N. dobula* from Tasmania, but differs from that species in not having the anal spines detached, and in the proportion between the length and the height. In having apparently two lateral lines it resembles *N. travale* (Castelnau) from Victoria, but differs considerably from that species.

I will take this opportunity of correcting a mistake in my description of *Neptomenus brama* in the "Catalogue of Fishes of New Zealand;" the length should be two and three-fourths the height of the body, and not four and three-fourths as there stated.

31b. DITREMA VIOLACEA, sp. nov. C.M.

Pl. VIII.

B. 4?; D. $\frac{10}{20}$; A. $\frac{3}{25}$; V. $\frac{1}{5}$; P. 19; L. lat., 93; L. trans., 14/28.

Length four times that of the head, or two and a half times the height of the body; snout rather longer than the diameter of the eye; teeth in villiform bands on both jaws, the vomer, and palatine bones; upper profile convex;

maxillary broad, produced to beyond the vertical from the anterior margin of the eye; margin of the præoperculum striated and finely denticulated; dorsal single, increasing in height as far as the second soft ray; anal higher than the dorsal, less than half the length of the head; pectorals shorter than the head, nearly twice as long as the ventrals, which are situated rather behind them; caudal forked.

Above violet, passing into white below; vertical fins violet at the base; a spot of dark violet in the axils of the pectorals; iris yellowish.

Wellington, 6th May, 1872.

This fish differs from the genus *Ditrema*, as characterized by Dr. Günther, in having teeth on the palate and a band instead of a single row on each jaw, but I do not think that this difference is sufficient to warrant a new genns being established for it. From *Platystethus* it differs both in having teeth on the palate, and in the dorsal fin.

It is said to be often mistaken for the warehou (*Neptomenus brama*), but the stronger dorsal spines, and the shorter pectoral fins easily distinguish it.

37. *Bovichthys variegatus*, Rich. (Cat., p. 24.)

Mr. Henry Travers brought a fine specimen of this fish from the Chatham Islands, which enables me to correct the description given in the "Catalogue of New Zealand Fishes," which was evidently taken from an immature specimen.

D 8–9 | 19 ; A 14.

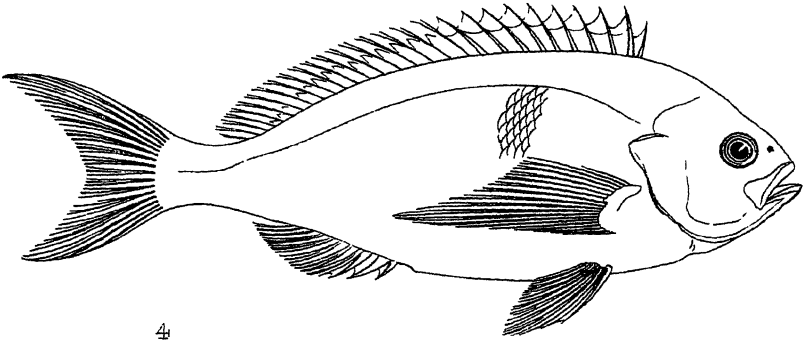
Length two and three-quarter times that of the head, or four and three-quarter times the height of the body; interorbital space more than half the diameter of the eye; soft dorsal as high as the body beneath; base of the spinous dorsal more than half the length of the soft; head rather compressed; interorbital space concave, with two small longitudinal ridges; caudal slightly rounded, with the rays protruding; ventrals not reaching to the vent; lateral line with about eighty flat spines under the skin, directed alternately upward and downward.

Purplish brown, marbled with darker, and a few whitish marks on the back; rays of the soft dorsal spotted with black.

The young, a specimen of which was also brought from the Chatham Islands, has five transverse black bars on the body and tail, and two on the caudal fin; the soft dorsal also is lower.

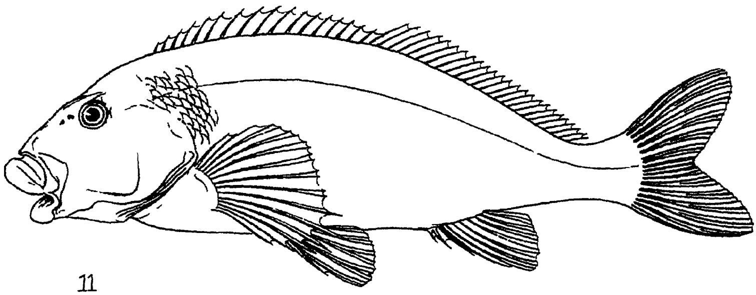
40. *Notothenia cornucola*, Rich. (Cat., p. 26.) C.M.

Specimens of this fish were brought by Mr. Henry Travers from the Chatham Islands, and I also saw it last January in Dunedin. The præoperculum is concave, and the top of the head is nearly smooth. The lateral



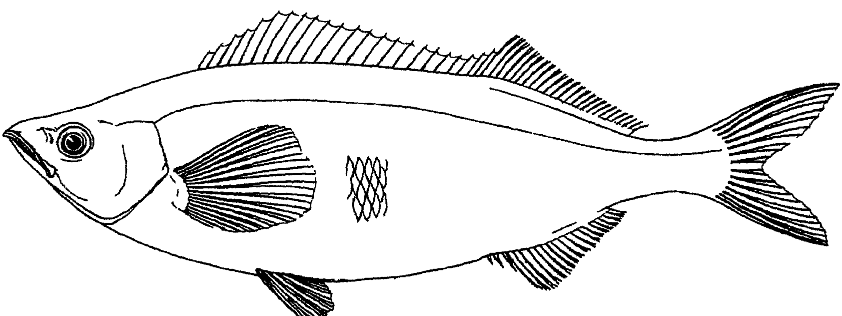
4

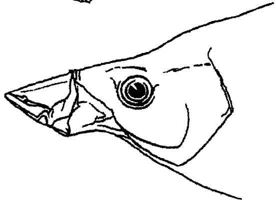
SCORPIS HECTORI, *Hutton.*



11

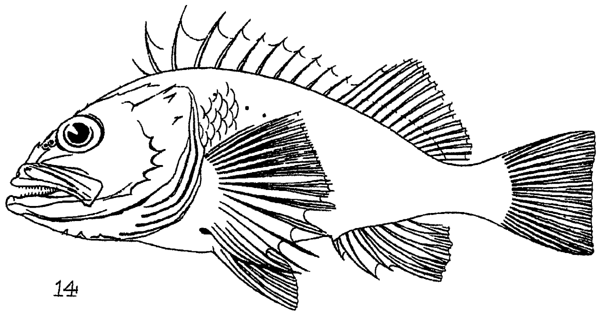
CHILODACTYLUS SPECTABILIS, *Hutton*





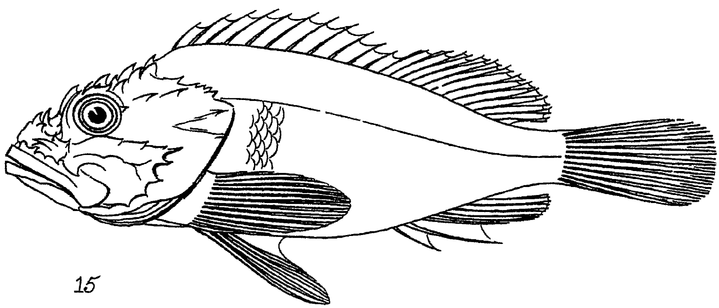
13 *a*

MENDOSOMA LINEATA, *Forst.*



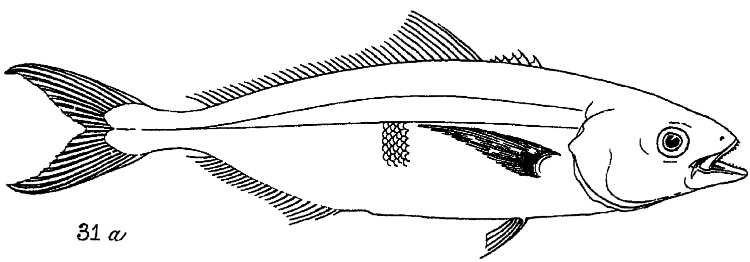
14

SEBASTES PERCOIDES, Sol



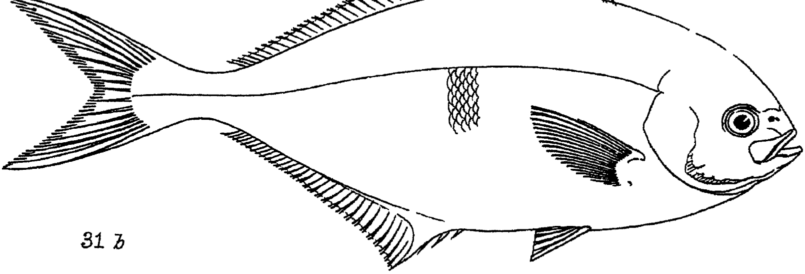
15

SCORPÆNA CRUENTA, Sol



31 a

NEPTOMENUS BILINEATUS sp nov



31 b

DITREMA VIOLACEA

line extends to the end of the second dorsal, while the posterior portion begins under the tenth ray from the end of the second dorsal.

41. *Lepidotrigla brachyoptera*, Hutton. (Cat., p. 27.) Pl. XV.

44. *Gobius amiciencis*, C. & V. (Cat., p. 29.)

Carteret harbour is not in New Zealand but in New Ireland; this fish should, therefore, be struck out of our list.

45. *Eleotris gobioides*, C. & V. (Cat., p. 29.) Pl. XV.

45a. ELEOTRIS RADIATA. Quoy. C.M.

Pl. IX.

E. radiata, C. & V., "Hist. Nat. des Poissons," XII., 250.

D. $6 \mid \frac{1}{9}$; A. $\frac{1}{9}$; L. Lat., 30?

Length three times that of the head, or six times the height of the body; interorbital space flat; scales moderate, minutely ciliated; snout moderate; head depressed, the breadth being rather greater than the height. Colour (in spirits) pale yellowish red, with several vertical brown bands on the caudal. Total length of the specimen two inches. This specimen was obtained near the mouth of the river Thames, where it appears to be not uncommon. The natives call it "kurahina."

Valenciennes gives the following description of the colours of the specimen taken by Quoy:—Reddish, with twelve vertical brownish bands on each side; fins whitish; the first dorsal with two longitudinal black bands, the upper large and dentate; the second dorsal with three less marked, the anal with one. The caudal with many vertical brown lines; at the base of the pectorals a blackish straight line.

47. *Trypterygium nigripenne*, C. & V. (Cat., p. 31.)

This fish is very variable in colour, and sometimes the nasal tentacle is wanting. Two specimens brought by Mr. Henry Travers from the Chatham Islands have a purplish lunate spot on the base of the pectorals, and thus resemble *T. forsteri*; but the fins were

D. 4–5 | 17–20 | 13–14; A. 21–25,

others were quite black, and others were of the typical colour. I am of opinion that *T. forsteri*, *T. fenestratum*, and *T. varium*, are only accidental varieties of *T. nigripenne*.

51. *Trypterygium compressum*, Hutton. (Cat., p. 32.) Pl. XV.

52a. CRISTICEPS AUSTRALIS, C. & V. C.M.

C. australis, Günther, III., 275.

$$\text{D. } 3 \left| \frac{27\text{-}29}{5\text{-}8} \right. ; \text{ A. } \frac{2}{23\text{-}25} ; \text{ V. } \frac{1}{3}.$$

Length equal to three and three-quarter times that of the head, which is equal to the height of the body. The first dorsal commences above the posterior margin of the orbit, and is nearly twice as high as the second. The lateral line ceases before the end of the pectoral fins. A simple tentacle above the eye, and a pair of bifurcated ones over the snout. Colour (in spirits) uniform reddish.

Bay of Islands and Cape Campbell.

53. *Sticharium rubrum*, Hutton. (Cat., p. 33.) Pl. IX.

In a letter to Dr. Hector, Dr. Gunther says that this fish does not belong to the genus *Sticharium*, but should be referred to *Clinus*. I kept both it and *Sticharium flavescens* out of *Clinus*, on account of the small number of soft rays in the dorsal, but as Dr. Günther says that they cannot be placed in the genus *Sticharium*, they will have to be called *Clinus rubrus* and *C. flavescens*, and will form a small group by themselves.

54. *Sticharium flavescens*, Hutton. (Cat., p. 33.) Pl. XV.

56a. TRACHYPTERUS ALTIVELIS, Kner. ? A.M.

T. altivelis, Günther, III., 303.

D. 200? A. 0.

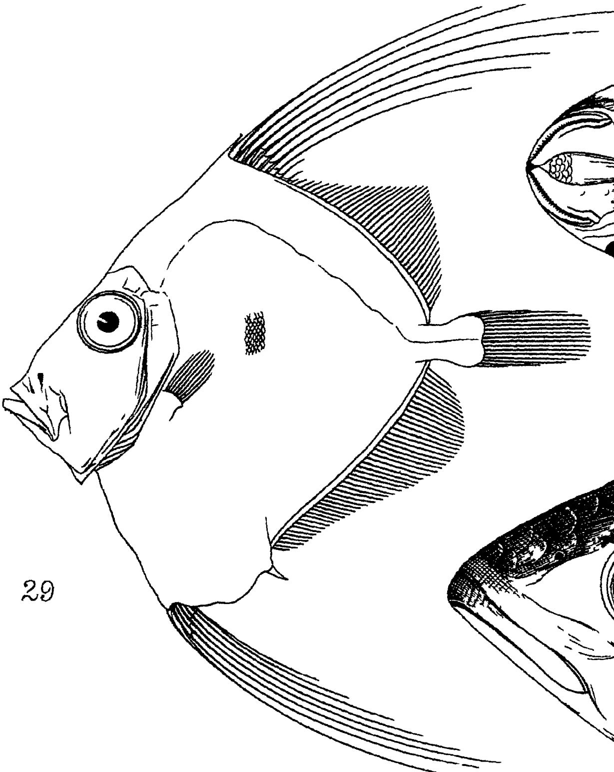
Length about seven times the greatest height of the body, which is at the base of the ventral fins; caudal nearly as long as the head, pointing obliquely upwards; upper profile deeply concave, descending rapidly from the eye; muzzle truncated; cleft of the mouth vertical. Total length 20 inches.

The above description is taken from a very bad specimen preserved in the Auckland Museum.

57. *Mugil perusii*, Val. (Cat., p. 36.) Pl. IX.

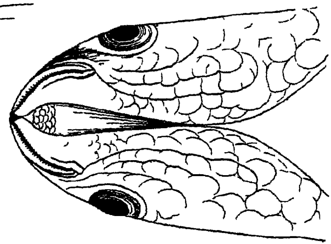
In a letter to Dr. Hector, Dr. Gunther says that he thinks that our mullet is identical with *M. cephalotus*, C. & V. It appears to me to differ slightly from this species in having the head broader, in the length of the anterior dorsal spine being less than half the length of the head, and in its being placed rather nearer the snout than the root of the caudal.

Judging from descriptions only, I should be inclined to think that our fish comes nearer to *M. ramelsbergii*, but besides the head being broader, the posterior nostril is placed as in *M. cephalotus*. The second dorsal is also placed further back than in either of these species; the angle formed by the

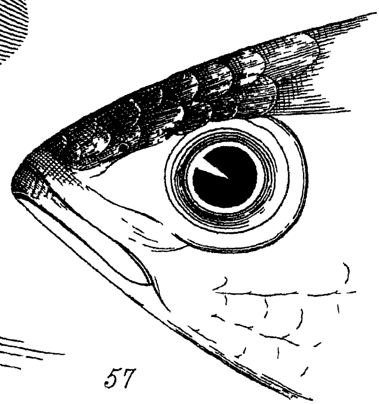


29

CYTTUS TRAVERSI, Hutton



57

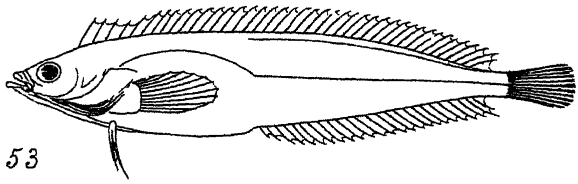


57

MUGIL CEPHALOTUS, Cuv. & Val. ?
(Mullet)

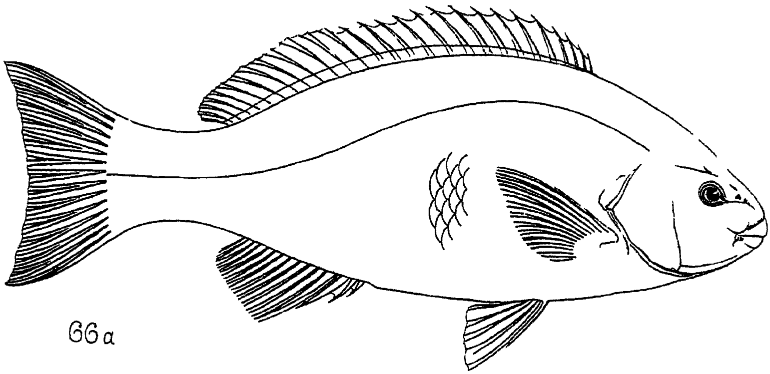
45 a

ELEOTRIS RADIATA, Quoy



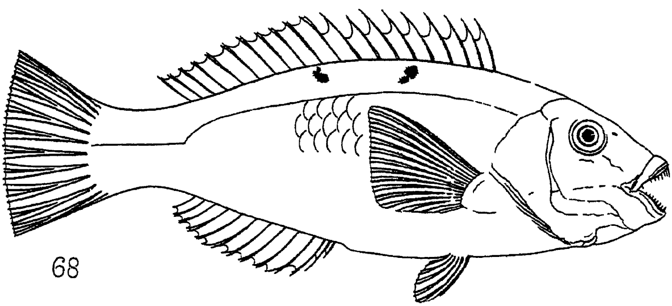
53

CLINUS



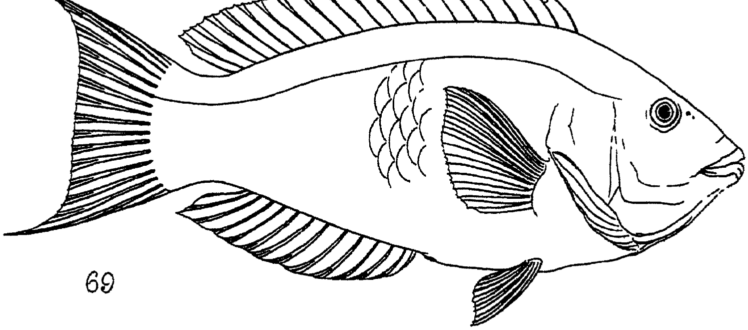
66a

CTENOLABRUS KNOXI, sp nov



68

LABRICTHYS BOTHRYOCOSMUS, Rich.



69

LABRICTHYS PSITTACULA Rich.

anterior margin of the mandible is slightly obtuse; and the space on the chin between the mandibularies is broader than the figure given of *M. cephalotus* by Dr. Günther. Nevertheless, I am quite willing to accept Dr. Günther's identification, if he still adheres to it.

64. *Trachelochismus pinnulatus*, Forst. (Cat., p. 40.)

Mr. Henry Travers brought several specimens of this fish from the Chatham Islands.

66a. CTENOLABRUS? KNOXI. sp. nov. C.M.

Pl. X.

B. 6; D. $\frac{15}{11}$; A. $\frac{3}{11\text{-}12}$; P. 14; V. $\frac{1}{5}$; L. lat., 64; L. trans., 8/17; Vert. 11/15.

Length two and three-fifths the height of the body, or four and a half times the length of the head; upper jaw longer; soft portion of dorsal only half the length of the spinous; operculum and præoperculum entire; imbricate scales on the cheeks and operculum; interoperculum naked; teeth in a broad villiform band, with an outer double series of longer, weak, compressed, flat-topped teeth in both jaws, no posterior canines; anal spines strong; base of the dorsal, anal, and caudal, scaly; abdominal portion of the vertebral column slightly shorter than the caudal portion.

Dark olivaceous black above, and greyish below; mouth, and a band to, and a little below, the eye tinged with yellowish; iris white.

Whangarei harbour; Cook Strait, Dr. Knox.

68. *Labricthys bothryocosmus*, Rich. (Cat., p. 43.) Pl. X.

69. *Labricthys psittacula*, Rich. (Cat., p. 43.) Pl. X.

69a. LABRICHTHYS FUCICOLA, Rich. C.M.

Labrus fucicola, Rich., "Voy. Ereb. & Terr.," p. 127.

"Cat. N.Z. Fishes," Pl. VII., fig. 68.

D. $\frac{9}{11}$; A. $\frac{3}{10}$; L. lat., 27; L. trans., 3/9.

Length two and four-fifths that of the head, or two and a quarter times the height of the body; two long anterior canine teeth in each jaw, the others graduated; about four rows of scales on the præoperculum; dorsal not scaly, spinous portion lower than the soft; caudal rounded.

Darkish purple, passing into light grey on the belly; a yellowish band from the mouth below the eye; four or five irregular yellow spots on the back under the dorsal, and the sides slightly varied with the same colour; humeral region yellowish; lips and pectorals reddish; ventrals black, except the bases, which are grey.

Wellington harbour; also found in Tasmania.

Total length, $13\frac{1}{4}$ inches.

This fish was figured by mistake in the "Catalogue of the Fishes of New Zealand," Pl. VII., No. 68, instead of *L. bothryocosmus*.

70. *Odax vittatus*, Sol. (Cat., p. 43.)

The following description is taken from a stuffed and highly-varnished specimen in the Otago Museum:—

D. 34; A. 15; V. $\frac{1}{4}$; P. 15; C. 14; L. lat., 75? L. trans., 8/16?

Length four and a half times that of the head, which is equal to the height of the body; length of the head nearly three times that of the snout; least depth of the tail less than half the distance between the dorsal and caudal; præoperculum sharply serrated; operculum with two points.

71. *Coridodax pullus*, Forst. (Cat., p. 44.)

Length four and two-thirds that of the head, or three and three-fifths that of the body; length of the head three and a half times that of the snout.

Purplish grey, lighter below, often with a broad pale band on each side from the mouth to the caudal; mouth, præoperculum, anal, and dorsal fins variegated with bright french blue; belly and under the pectorals sparingly variegated with yellow; lips purplish red; ventrals and pectorals variegated with the same colour.

72. *Gadus australis*, Hutton. (Cat., p. 45.)

In a letter to Dr. Hector, Dr. Günther says that this fish should be referred to the genus *Merluccias*, and that it is probably identical with *M. gayi*, from Chile, an opinion with which I quite agree.

74. *Lotella rhacinus*, Forst. (Cat., p. 46.)

Mr. H. Travers brought specimens of this fish from the Chatham Islands. They are of a pale uniform brown in spirits.

CALLOPTILUM, gen. nov.

Body fusiform, compressed posteriorly; scales cycloid; three dorsal fins, the first reduced to a single ray; anal single, long; ventrals long, composed of two rays; caudal separate; teeth none; gill openings wide, the gill membrane united below the throat, but not attached to the isthmus; pseudobranchiæ none; snout short and rounded.

This genus comes next to *Bregmaceros*, Thompson, afterwards called *Calloptilum* by Sir J. Richardson, which name I have now adopted for the present genus.

76a. CALLOPTILUM PUNCTATUM. sp. nov. C.M.

Pl. XI.

D. 1 | 11 | + 18 ; A. 44 ; V. 2.

Length five times that of the head, which is about equal to the height of the body; first dorsal ray situated over the pectorals, nearly as long as the head; third with the anterior portion rudimentary; anal commencing in front of the second dorsal; ventral rays not reaching to the vent, which is situated at about one-third of the distance from the snout to the end of the caudal; mouth large, the maxillary extending behind the eye; upper profile convex, with a prominent ridge along the top, from the eye to the snout.

Colour (in spirits) silvery; back, base of the pectorals, and caudal, with minute black dots.

Total length, 4½ inches.

Mouth of the River Thames and Cape Campbell.

Called "ahuruhuru" by the natives.

78. *Macrurus australis*, Rich. (Cat., p. 49.)

This fish appears to be common in Lyttelton harbour. Mr. J. D. Enys informs me that when first caught it emits such a strong phosphorescent light that a book can be read by its means.

79. *Coryphœnoides novæ-zealandiæ*, Hect. (Cat., p. 49.)

In a communication to Dr. Hector, Dr. Günther proposes to place this fish in a new genus which he calls *Macrurorus.*

82a. AMMOTRETIS GUNTHERI. sp. nov. C.M.

Pl. XI.

B. 7 ; D. 94 ; A. 73 ; V. dext. 10, sinist. 2 ; P. dext. 12, sinist. 9 ; C. 17 ; L. lat., 90 ; L. trans., 31/38.

Length equal to five times that of the head, or not quite twice the height of the body; snout produced into a flap overhanging the lower jaw, about twice as long as the eye, which is one-sixth of the length of the head; lower lip with a fringe of soft rays; mouth small; interorbital space scaly, about one-half the vertical diameter of the eye; lower eye in advance; right ventral commencing on the chin; anterior rays of dorsal and right ventral almost free; longest rays of dorsal go about two and a half times into the length of the head; caudal rounded, about as long as the head.

Right side olivaceous with black spots, the spots more or less arranged in longitudinal rows; fins and flap on snout tinged with red; left side yellowish white.

Wellington harbour, November, 1872.

The total length of this fine new flat-fish was 16½ inches, with plenty of

flesh on it. I have named it in honour of Dr. A. Günther, F.R.S., without whose previous labours it would have been impossible for me to have drawn up my "Catalogue of the New Zealand Fishes."

83a. RHOMBOSOLEA LEPORINA, Gunth. C.M.

Pl. XI.

R. leporina, Günth. "Cat. Fish. Brit. Mus.," IV., p. 460.

B. 5; D. 65; A. 42; V. 6; P. 12.

Length three and a half times that of the head, or twice the height of the body; snout longer than the diameter of the eye, which goes eight times into the length of the head; interorbital space less than the vertical diameter of the eye; upper lip rather longer, notched; cutaneous fold well developed; anterior dorsal rays produced beyond the membrane, the tips bifid; pectorals rather more than half the length of the head; the longest dorsal spine goes three and a half times into the length of the head; caudal rounded.

Above brown, marbled with darker; below yellowish, with small irregular black spots; dorsal with seven, and anal with four, round blackish spots.

Bluff harbour; Wellington, where it is known as "yellow-belly"; found also in Australia.

83b. RHOMBOSOLEA TAPIRINA, Gunth. C.M.

Pl. XII.

R. tapirina, Hect., "Cat. Col. Mus.," p. 80; Günther, IV., 459.

B. 6–7; D. 66; A. 48; V. 6; P. 9.

Length three and a quarter times that of the head, or nearly twice the height of the body; the diameter of the eye goes seven times, and the length of the snout five and three-quarter times into the length of the head; interorbital space equal to the vertical diameter of the eye; eyes divided by a narrow ridge; upper lip deeply notched; cutaneous fold and gill openings as in *monopus*; upper pectoral fin about half the length of the head; anterior dorsal rays produced beyond the membrane, the tips bifid; longest dorsal ray about one-third the length of the head; dorsal and anal terminating at a distance from the caudal, which is equal to one-fourth of the least depth of the tail; caudal about one-sixth of the total. Body covered with broad, deep, rounded, or quadrilateral depressions, in which the scales are imbedded.

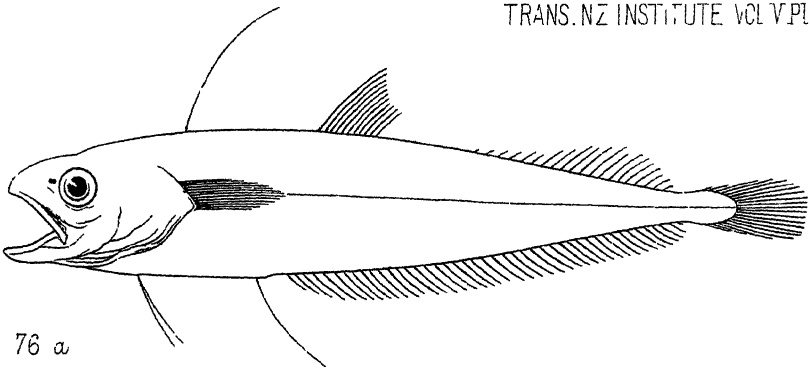
Brownish black, marbled with olivaceous; below greyish.

Wellington harbour.

Var. B.

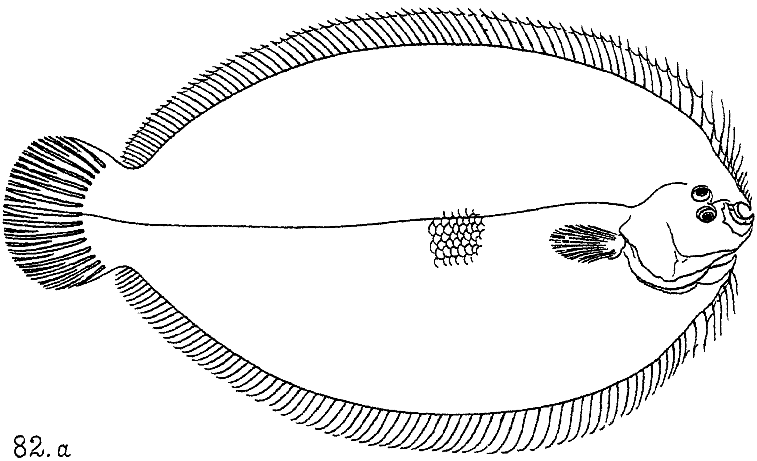
D. 62; A. 44; L. lat., 80; L. trans., 22/29.

Above brown, with red spots; below whitish, marbled with brown. A fleshy lobe on the left side of the lower jaw; scales smaller.



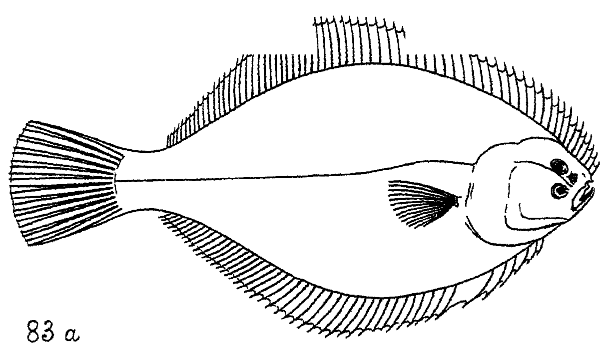
76 a

CALLOPTILUM PUNCTATUM sp. nov

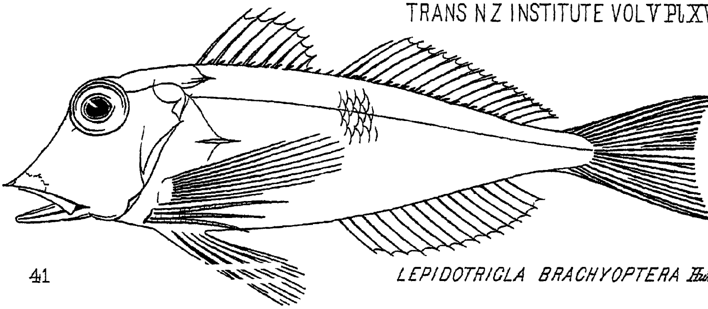


82. a

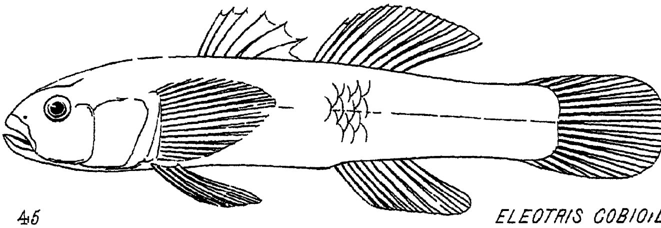
AMMOTRETIS GUNTHERI. sp nov



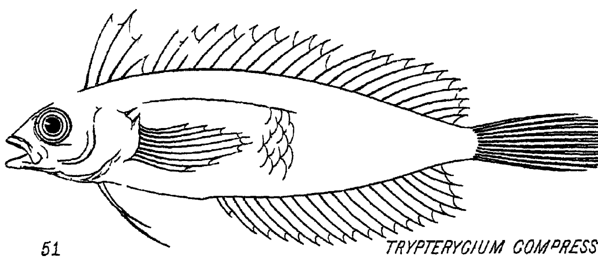
83 a



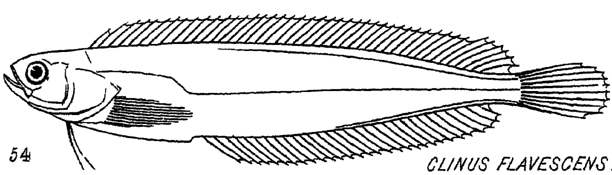
41 LEPIDOTRICLA BRACHYOPTERA Hutton



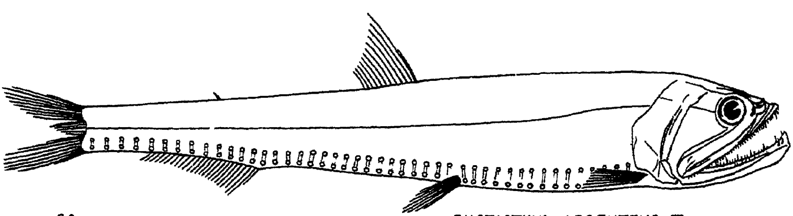
45 ELEOTRIS GOBIOIDES C&V



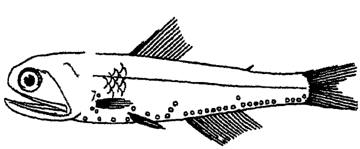
51 TRYPTERYGIUM COMPRESSUM Hutton



54 CLINUS FLAVESCENS Hutton



90 PHOTICTHYS ARGENTEUS Hutton



a SCOPELUS PARVIMANUS, Gunth

Bluff harbour.

Found also in Australia and the Auckland Islands.

87. *Arrhamphus sclerolepis*, Günth. (Cat., p. 54.)

Dr. Krefft states that this fish comes from Fitzroy River, in Queensland; it should therefore be struck out of our list.

90. *Phosichthys argenteus*, Hutton. (Cat., p. 56.) Pl. XV.

In a letter to Dr. Hector, Dr. Günther suggests that the name of this genus should be altered to *Photichthys*, a suggestion that I willingly adopt.

90a. SCOPELUS PARVIMANUS, Gunth? C.M.

Pl. XV.

S. parvimanus, Günth., V., p. 406.

D. 12; A. 15; V. 8; L. lat., 38; L. trans., 3/4.

Length four and a half times the height of the body, or three and a half times the length of the head; least depth of the tail one-half the height of the body; the depth of the head is contained once and one-third in its length; eye large, rather less than one-third of the length of the head; snout short, rounded; cleft of the mouth slightly oblique, with the lower jaw slightly prominent; the maxillary reaches to the angle of the præoperculum, and terminates in a triangular dilatation. The origin of the dorsal fin is rather nearer the snout than the root of the caudal, slightly in advance of the base of the ventrals, and the last ray a little in advance of the anal. Pectorals short, not extending much beyond the base of the ventrals; scales cycloid, concentrically striated, those of the lateral line raised. There are fourteen phosphorescent spots on each side behind the anal, five on each side between the anal and the ventrals, two on each side above the end of the ventrals, and one on each side above their base; also six in a double row between the head and the ventrals, and one at the point of the operculum. An elliptical pearl coloured patch on the back of the tail.

Total length of the specimen $2\frac{1}{2}$ inches.

Cape Campbell, January, 1873.

90b. SCOPELUS BOOPS, Rich.

Myctophum boops, Rich., p. 39; *S. boops*, Günth., V., 408.

D. 14; A. 20–22; V. 8; L. lat., 37–39; L. trans., 3/5.

Origin of the dorsal considerably nearer to the end of the snout than to the root of the caudal, above the root of the inner ventral rays; its last ray is before the vertical from the origin of the dorsal fin. The pectorals extend to the vent.

Sea between Australia and New Zealand (Dr. Hooker); Vancouver Island.

I have seen no specimens.

90c. SCOPELUS CORUSCANS, Rich.

Myctophum coruscans, Rich., p. 40 (not of C. & V.)

D. 12; A 20; C $17\frac{6}{6}$; P. 17, V. 8; L. lat, 38.

Eye moderate, less than one-third the length of the head; dorsal commences a little behind the ventrals; the pectorals extend nearly to the vent.

Sea between Australia and New Zealand (Dr. Hooker); South Atlantic.

I have seen no specimens.

Dr. Gunther (V., p. 413) remarks that this fish is very like *S. coccoi*. The typical specimens appear to be lost.

92 *Retropinna richardsoni*, Gill. (Cat., p. 58)

Mr. H. Travers brought specimens of this fish from the Chatham Islands.

94a. GALAXIAS OLIDUS, Gunth. C M

G. olidus, Gunth., VI, p 209.

D. 11; A. 13; P. 14; V. 7.

Length five times that of the head, which is rather more than the height of the body; head broad and depressed, upper jaw longer, mouth wide, the maxillary extending to the middle of the eye, diameter of the eye rather more than one-sixth the length of the head, and about half the length of the snout; interorbital space more than twice the diameter of the eye, the length of the pectoral goes two and a half times into the distance of its root from the ventral, and the length of the ventral is more than half the distance to the anal, the anal if laid back extends just to the base of the caudal. The depth of the body in front of the dorsal is one-sixth of the length, and the least depth of the tail is one-half of the distance between the dorsal and caudal.

Yellow, with small black spots on the head, opercles, back, sides, and fins.

Total length of the specimen 7 inches.

Lake Wakatipu. Presented to the Colonial Museum by J. S. Worthington, Esq.

This fish appears to be identical with *G. olidus* in form and dimensions, but to differ from it in colour.

99. *Engraulis encrasicholus*, L. (Cat, p. 62)

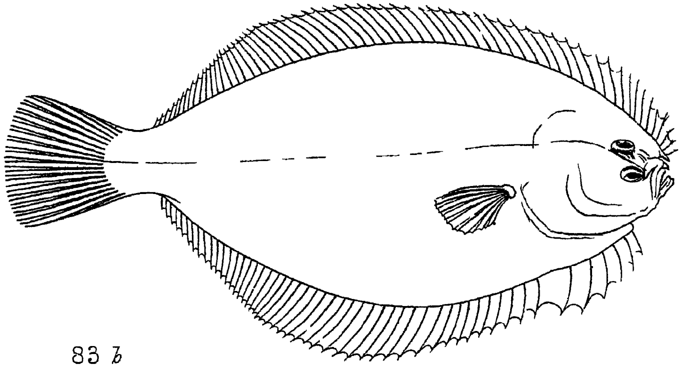
Var. *antipodum*, Günth.

This fish is found at the mouth of the river Thames; the natives there call it "korowhawha."

100a. *Clupea sprattus*. Pl. XII.

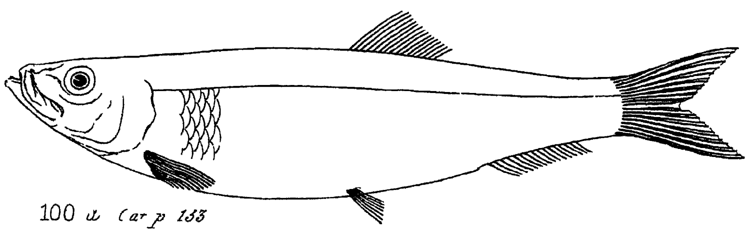
Var. *antipodum*, Hector, "Fishes N.Z.," p. 133.

This fish is called "kupai" by the Thames natives.



83 b

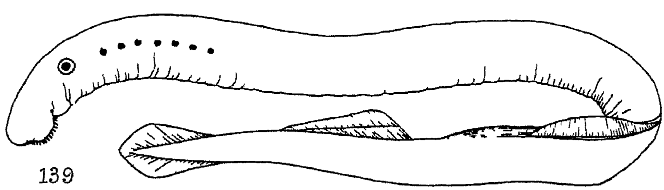
RHOMBOSOLEA TAPERINA, Gunth



100 a Car p 153

CLUPEA SPRATTUS, var ANTIPODUM. Hector

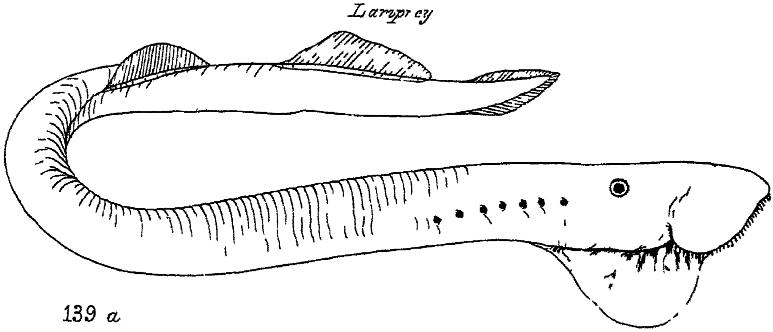
Sprat



139

CEOTRIA CHILENSIS Gray

Lamprey



139 a

CEOTRIA AUSTRALIS. Gray

J.B del et lith

103. *Anguilla latirostris*, Risso. (Cat., p. 65.)

Mr. Henry Travers brought three specimens of this eel from the Chatham Islands.

112. *Solenognathus spinosissimus*, Günth. (Cat., p. 69.)

Last April I saw a nearly fresh specimen of this fish that had been picked up at the Bay of Islands; it was of a uniform pale yellowish colour.

114. *Monacanthus convexirostris*, Günth. (Cat., p. 71.)

When fresh this fish is of a darkish grey colour, with the dorsal and anal fins, as well as the iris, bright yellow.

115a. ARACANA AURITA, Shaw. C.M.

A. aurita, Günth., VIII., p. 266.

Carapace compressed, rough with papillæ, posterior edges sinuated, five-keeled, those on each side of the back and abdomen slight, that on the lower part of the abdomen strong; a spine over each eye, two of equal size and near together on each dorsal ridge, a single one on each side, and two of equal size on the keels on each side of the abdomen, the foremost situated at about the vertical from the tip of the pectoral fin.

Yellowish, with thin irregular undulating brown longitudinal stripes.

Two specimens were left at the Museum, the donor and locality unknown. Found also in Tasmania and South Australia.

117. *Chilomycterus jaculiferus*, Cuv. (Cat., p. 73.)

In a letter to Dr. Hector, Dr. Günther says that he finds that this fish should be referred to the genus *Dicotylicthys.*

118. *Orthagoriscus truncatus*, Lacep. (Cat., p. 73.)

Since the "Catalogue of New Zealand Fishes" was published I have had an opportunity of examining the sun-fish in the Auckland Museum, and I find that it belongs to *O. mola* and not to *O. truncatus.*

122. *Zygæna malleus*, Risso. (Cat., p. 76.)

A small specimen of this shark has lately been caught in Auckland harbour.

127. *Notidanus indicus*, Cuv. (Cat., p. 79.)

A specimen of this shark is in the Auckland Museum.

131. *Euprotomicrus*, sp. (Cat., p. 81.)

I now believe that the jaws which I doubtfully referred in the "Catalogue of New Zealand Fishes" to this genus really belonged to a young specimen of *Carcharias brachyurus.*

139. *Geotria chilensis*, Gray. (Cat., p. 87.) Pl. XII.

Riwaka River, Nelson.

139a. GEOTRIA AUSTRALIS, Gray. C.M

G. australis, Günth., VIII., p. 508.

Pl. XII.

Skin on the throat dilated into a large sac; maxillary lamina thin, crescent shaped, with four sharp teeth, the middle pair of which are only half as broad as the outer; mandibulary lamina very low, slightly sinuous; suctorial teeth in numerous series, rather distant from one another; anicuspid small, those nearest to the mouth rather larger; only one transverse series of very small teeth between the mandibulary lamina and the posterior lip, which, as well as the remainder of the margin of the disc, is beset with numerous broad leaf-like fringes; suctorial disc subtriangular, with the lateral lobes very broad; dorsal fins widely separated.

Uniform blackish; in spirits bluish black (Günther).

Stewart Island; found also in South Australia.

Art. XXIX.—*Notes on some Undescribed Fishes of New Zealand.* By Julius Haast, Ph. D., F.R.S., Director of the Canterbury Museum.

(With Illustrations.)

[*Read before the Philosophical Institute of Canterbury, 7th August,* 1872.]

The excellent "Catalogue of the Fishes of New Zealand," drawn up by Capt. Hutton for the Colonial Museum in Wellington, which forms a welcome addition to the scientific literature of the Colony, and to the careful edition of which I wish to bear my testimony, has afforded me an opportunity of naming the specimens of fishes in the Canterbury Museum with greater facility than otherwise would have been the case, as well as to see at a glance which genera and species are still unrepresented in the provincial collections.

At the same time that little work has shown me that we possess in the collections under my charge several species which are either unrepresented in the Colonial Museum or are new to science.

In the following notes I shall therefore give a description of a few species which form an addition to the Catalogue, adding a short diagnosis to each. In one or two instances I shall propose a change in the nomenclature, that adopted by Capt. Hutton not appearing to me to be quite appropriate.

Haplodactylus donaldii. sp. nov.

Capt. Hutton in his Catalogue states that Richardson mentions a fish under the name of *Aplodactylus meandratus* as having been caught off Cape Kidnappers, but that it appears that there is no description of it. Dr. Gunther

on the other hand, in his classical Catalogue of Fishes, does not even mention such an occurence, although he describes five species which have all been obtained either from the western coast of South America or from those of Australia, the genus thus being an inhabitant of the Pacific Ocean only.

It may be that the species described by Richardson belongs to some other genus, as it has also been mentioned by Solander, and Banks has given a figure of it. I may also add that none of the five species described by the accomplished ichthyologist of the British Museum agrees with our New Zealand specimen, and which thus may be fairly claimed as an addition to the New Zealand fauna.

It was named in honour of Dr. Donald, of Lyttelton, who presented it to the Museum, and to whom we owe so many valuable additions to our collections.

D. 15 | 18 ; A. $\frac{3}{7}$.

Incisors tricuspid, placed in a band on both jaws, and in several rows of which the outer series contains the largest. The six lower pectoral rays simple. The ground colour is black, all mottled with slaty grey; abdomen slaty grey, the same colour as the spots; fins mottled black and slaty grey, like the body, with the exception of the pectoral fins, which are nearly black.

DESCRIPTION.—The greatest height of the body is four times in the total length, and is below the fifth dorsal spine, the upper profile of the head and nape of the neck is rather concave; the head, which is only slightly convex between the orbits, is one-fifth of the total length; the operculum terminates posteriorly in a point and is entire, differing in that respect from *H. punctatus*, and *lophodon*, in which this limb is divided by a deep semicircular notch.

The dorsal fin beginning in a vertical line from the extremity of the operculum has the first spine small, 5 lines, the second 11 lines, the third 1 in. 3 lines, which is the average height of fourth, fifth, and sixth, after which the spines gradually diminish to the fifteenth or last spine. It is continued by the soft one, which rises at once to 1 in. 3 lines, gradually reaching a height of 1 in. 7 lines at the seventh ray, after which it gradually diminishes to 7 lines at the last ray.

A pad along the base of the dorsal fin is broadest at the base of the third spine, gradually decreasing towards the middle of the soft one.

	In.	Lines.
Total length	14	1
Length of head	3	0
Height of body	3	6
Diameter of eye	0	5
Interspace between dorsal and caudal fin	1	10
Length of caudal lobe	2	1
Interspace between ventral and anal fin	3	4

SYNNEMA.* Gen. nov.

Uranoscopus, Cuv. au Val. *Anema*, Günth., II., 230. *Kathetostoma*, Hutton, 23.

Habit and teeth of *Uranoscopus*; scales very small; a filament in the interior of the mouth; one continuous dorsal; ventrals jugular; pectoral rays branched; some bones of the head armed—six branchiostegals; pseudobranchiæ.

Synnema monopterygium, mihi.
Anema „ Günther,
Kathetostoma „ Hutton.

This species since the days of Solander and Forster has undergone several changes in its nomenclature, the latest being that proposed by Capt. Hutton, because he finds a filament in the mouth, so that the generic name of *Anema* of Günther (without filament) would be quite inappropriate. The species cannot again be united with *Uranoscopus*, as it possesses one dorsal only, while it cannot be placed with *Kathetostoma*, as Capt. Hutton has proposed, because the three spines on the inferior margin of the præoperculum, the two on the mandibula and two on the throat, which form amongst others a very important character of that species, are absent in the genus under review.

The Canterbury Museum possesses two specimens of this curious genus, of which one (11 in. 6 lines long) was caught in the river Avon, near Christchurch, and the other (15 in. long) in the river Rangitata, about forty miles above its mouth, by Mr. W. Packe, who presented it to the Museum.

This species, as far as the specimens in the Canterbury Museum are concerned, is fluviatile in its habits, but I suppose that it inhabits both salt and fresh water periodically.

I may also here observe that at least some of this tribe, which all bury in the sands or mud lying there in wait for their food passing over their mouth, can remain above low-water mark during the ebbing of the sea, as one of my sons when digging for shells in the sands on the beach near the Sumner Hotel not far below high-water mark came upon a specimen about 15 in. long. It was carried by him to a pool of water with a sandy bottom, but the fish disappeared in an incredibly short space of time, having buried itself in the sands.

KATHETOSTOMA GIGANTEUM. sp. nov.

The Canterbury Museum received from Mr. Day, in Sumner, a very large specimen of cat-fish, caught in the Heathcote estuary, near Sumner, which upon examination proved new to science.

This magnificent specimen, which, as far as I could ascertain, is the largest

* From *syn* with, and *nema* filament.

cat-fish hitherto described, is 29 in. long, 11 in. 9 lines broad, and 7 in. 2 lines high.

DESCRIPTION OF SPECIES.

D. 16; A. 14; P. 22; C. 11; V. 5.

Length of the head is four times in the total; teeth large and bent inwards in several rows, but not closely set; six branchiostegals; three strong spines on the inferior margin of the præoperculum, two below the mandibula, and two on the throat; head partly rugose and covered with numerous grains starting from star-like centres and forming regular figures; one dorsal, of which the rays are slight and entire, whilst those of the ventral, pectoral, and anal fins are strong and branched; lateral line straight, and only slightly bent down near its junction with the caudal. From the neck and the anterior portion of the lateral line, which stands well above the skin, start numerous raised flat lines, branching repeatedly and diminishing gradually, the whole forming an elegant pattern; interorbital space deeply excavated; scales none.

Head and back of a brown olive colour, with darker undefined spots; sides and abdomen and fins light brownish yellow. The upper surface of the body is like the head remarkably flat.

LEPTOSCOPUS HUTTONII.* sp. nov.

D. 31; A. 36; L. lat., 88 (44).

Length four and a quarter times that of the head, which is eight times the diameter of the eye. A strong and well pointed humeral spine; caudal rays branched (and in specimen B. also ventral rays); the scales of the lateral line twice as large as those of the adjoining series, each corresponding to the transverse series.

The Canterbury Museum possesses two specimens, which were both caught in the river Avon. The smaller one (A), presented by Mr. E. Barker, of New Brighton, is 11 in. long, and was caught near that locality.

Colour.—Head above and back dark olive green, the posterior portion of the latter becoming gradually lighter; cheeks, sides and abdomen white, the lateral line dark olive throughout, forming the division between the two colours; anterior portion of sides, above pectoral fins, below lateral line olive green, gradually shading off into white, with a few darker spots near the junction; pectoral fins above dark olive, nearly black, below white; anal fin white; dorsal fin white, with dark olive green rays and a fringe of the same colour; caudal fin—central portion white, with a dark line entering it at the base as a continuation of the lateral line for a third of its length, upper and lower portion dark olive green, like body.

* Named in honour of Captain Hutton, F.G.S., author of "Catalogue of New Zealand Fishes."

The second and larger specimen (B) is 18 in. long, and far brighter coloured than the first. Head above and back dark olive green, which is also the colour of the lateral line; middle portions of cheeks and side white; throat and abdomen pink; anal fin pink; pectoral fin above dark olive, centre white, below pink, corresponding to position of colours of the body; dorsal fin white, with dark olive green rays and fringe; caudal above and below dark olive green, centre white, fringed below with pink.

Besides in the colour there are some minor points of difference between the two specimens, such as form of the operculum, so that possibly they might represent two distinct species, in which case I would propose for the latter the name of *Leptoscopus tricolor*.

NOTOTHENIA MAORIENSIS.* sp. nov.

Maori Chief.

D. 3 29; A. 23; V. 6; L. lat. 58.

Length of the head one-fourth of the total, of which the height of the body is one-sixth; total length 17 in.; eyes slightly directed upwards; the upper surface of head is flat and granulated; suborbital space, upper portion of præoperculum and operculum covered with scales, the two latter naked below. The lateral line stops in a vertical line with the root of the last dorsal spine, whilst its lower continuation begins again under the twenty-sixth dorsal spine, so that the latter overlaps the upper one.

The whole rays of the pectorals are branched; colour black, with the exception of the abdomen, which is light grey, the sides shading off gradually into that colour; rays black; membrane brownish grey.

Caught near Lyttelton harbour, where, according to the fisherman who brought it, it is very seldom seen. The dark colour and the peculiar expression of the face has given rise to the popular name of Maori Chief, which has suggested to me the proposed specific designation.

BOWENIA.† gen. nov.

Eyes on the right side, the lower rather in advance; mouth unsymmetrical, narrower on the right side than on the left, the length of the left maxillary being one-fourth of that of the head; teeth villiform on the blind side only where they form bands; dorsal and anal rays entire, with the exception of the few largest ones, which are slightly divided; dorsal and anal fins scaleless; the dorsal fin commences on the extremity of the snout and is not continued on to the caudal; the two ventrals are conjoined at the junction with the

* Capt. Hutton considers this to be the same fish as No. 39, "Cat. N.Z. Fishes."—Ed.

† So named in honour of his Excellency Sir George Bowen, G.C.M.G., Governor of New Zealand.

anal fin; scales small cycloid; lateral line straight; gill openings narrow, the gill membranes being broadly united below the throat.

BOWENIA NOVÆ-ZEALANDIÆ. sp. nov.

D. 56; V. 6; A. 37; P. 11.

The height of the body is contained two and one-eighth in the total length without caudal, the length of the head nearly four times; the lower eye is in advance of the upper by about one-half of its diameter, they are separated by a naked space, which is about equal to the vertical diameter of the eye; snout as long as the eye, which is one-fifth of the length of the head; the maxillary of the right side extends below the anterior margin of the eye; teeth minute, in villiform bands; anterior rays of dorsal fin produced beyond the connecting membrane; the dorsal fin commences on the foremost part of the snout, its longest ray being the thirty-first, situated a little behind the middle of the fin; caudal straight, of equal length with the head; the gill opening does not extend upwards beyond the base of the pectoral; the two ventral fins are joined posteriorly, and are connected by a complete membrane with the anal fin; the length of the pectoral two-thirds that of the head.

Total length 10 in. 7 lines.

Uniform light brownish olive.

Lake Ellesmere.

The Canterbury Museum possesses from the same lake—which generally contains brackish water, and only at some seasons salt water, when in direct communication with the sea—two other specimens, 12 in. 3 lines and 12 in. 1 line total length, which agree with the foregoing description of *B. novæ-zealandiæ*, with the exception that the right ventral fin is only continuous in the same line with the anal fin, being joined to it by a broad and complete membrane without rays, the *left* ventral fin occurring separate.

However, this difference may be accounted for by the connecting membrane of that left ventral having been torn off in both specimens, of which one is not in a good state of preservation.

Another and striking peculiarity consists in the very strange form of the head of both. The dorsal fin, instead of commencing on the foremost part of the snout, does not reach to the head, the skull being covered with skin to the post-frontal bone; the left eye lying nearly on the top of the head. A little distance behind that eye the body rises, forming here, as it were, a crest or free pointed process projecting over the eye. On the foremost part of that crest the dorsal fin begins.

I should at once have considered both specimens as monstrosities, brought about by arrested development, had I not found both specimens alike, but

since then having read Dr. Traquair's important paper "On the Assymetry of the *Pleuronectidæ*," ("Trans Linn. Soc.," XXV., pt. ii., 1865), I have become convinced that they are both monstrosities, which, as I understood since from the fishermen, are far from uncommon.

GALAXIAS GRANDIS. sp. nov.
Bull-trout.

B. 9; D. 13; A. 13–15; V. 7; P. 14.

Head one-fifth of the total length, and one and one-third the height of the body; dorsal a little in advance of the anal; both jaws of equal length; eye rather small, one-seventh of the length of the head and one-half of the length of the snout; the length of the pectoral fin is two and a half the distance from the ventral; the anal extends beyond the base of the caudal if laid backwards; the least depth of the tail is one and one-fourth the distance between dorsal and caudal fins, teeth on tongue very large.

Brownish black above, yellowish brown beneath, with yellowish spots and short streaks, which are most numerous and best defined on the sides, whilst on the back and the head they are small and of rare occurrence; fins brownish black with lighter coloured rays. It will be seen that this species, although similarly coloured to *G. alepidotus*, is distinguished from it by its great size and some other specific differences.

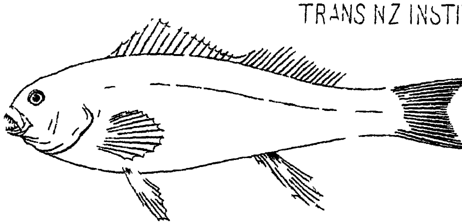
Total length 19 in. 3 lines.

I have been informed that even larger specimens have repeatedly been taken. I have not seen any specimens of *G. alepidotus*, so that I am unable to point out more fully all the specific differences, which I have no doubt exist.

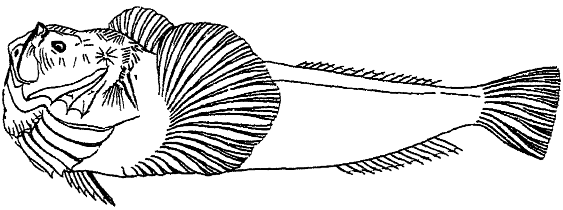
This giant bull-trout was obtained by Mr. E. Jollie in one of the small creeks near Lake Ellesmere, which rise as fine copious springs on the plains in its neighbourhood, and fall either into that lake or form branches of the Little Rakaia. These deep creeks, possessing generally vertical or overhanging banks, and having the bottom mostly covered by aquatic vegetation, to which the water-cress (*Nasturtium officinale*) forms in many instances a successful rival, are also inhabited by the New Zealand eel (*Anguilla aucklandii*), and it is rather astounding that they should offer shelter to two such voracious species—considering that very often the water-way is so narrow that a large fish like the bull-trout can scarcely turn round.

This bull-trout is easily caught with the hook baited with the grass-hopper during the summer time—and at any time of day.

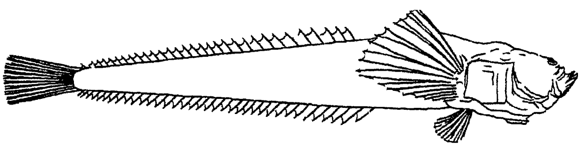
This species occurs also at the West Coast, where I obtained it in Lake Hall, the outlet of which falls into the Paringa river.



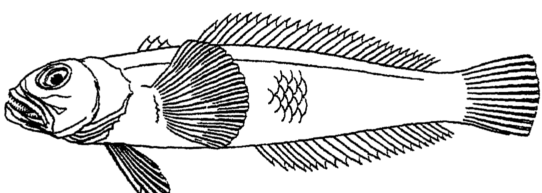
HAPLODACTYLUS DONALDII, Haast



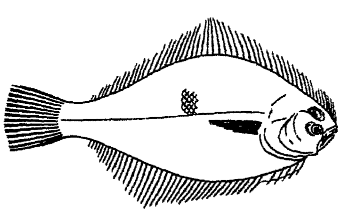
KATHETOSTOMA GIGANTEUM, Haast



LEPTOSCOPUS HUTTONII, Haast



NOTOTHENIA MAORIENSIS Haast



BOWENIA NOVÆ ZEALANDIÆ, Haast

J.F.M'Cardell del. J.B. lith.

ART. XXX.—*Notice of a New Species of Moth in New Zealand.*

By WALTER L. BULLER, D. Sc., F.L.S., &c.

(With Illustration.)

[*Read before the Wellington Philosophical Society, 6th November,* 1872.]

DURING an expedition into the Ruahine ranges in the summer of 1867, in quest of the Huia (*Heteralocha acutirostris*), I was fortunate enough to discover the fine species of nocturnal moth described below, and figured in Pl. XXII.

After a careful examination of the large type collection in the British Museum, I feel no hesitation in referring this new form to the genus *Porina*, and in giving the species a distinctive name. I have dedicated it to my friend Captain Gilbert Mair, who accompanied me on the occasion referred to.

So far as is at present known, the habitat of *Porina mairi* is confined to the wooded summits of the Ruahine ranges, in the Province of Wellington. I have never met with it during my frequent travels in other parts of the country, nor have I ever seen a specimen in any public or private collection.

BOMBYCINA.

Family *Hepialidæ*, Stephens.

Genus *Porina*, Walker.

Lep. Het. B.M. VII., p. 1572. (1856.)

P. MAIRI. sp. nov.

Alæ magnæ, sordide testaceæ; anticæ maculis sex marginalibus, albo introrsum cinctis; maculis subseptem, seriem submarginalem formantibus, sagittatis, nigris; septem, quarum quinque superioribis alboaliis testaceo-cinctis, discalibus; fascia transversa pone has fusca, lituris nigris utrinque limitata; lineis tribus irregularibus nigris, fusco impletis, pone cellam fasciam latam formantibus; macula parva media triangulari alba; nebula irregulari infra cellam pallide ochracea; macula diffusa cellam terminante alba, crucibus duabus nigris interrupta; fasciolis duabus divergentibus discoideis, albo cinctis, tertia apud basin sordide testaceo cincta; plagis tribus inæqualibus internis et maculis duabus sub-basalibus, nigris: posticæ griseæ, area externa fuscescente nigro 8 fasciata: corpus fuscum: exp. alar. circ. unc. 5, lin. 11.

Wings large, broad, front-wings produced, ovate-triangular, pale dirty testaceous; six black spots terminating nervures on outer margin, and bounded by a lunated marginal white band; a sub-marginal series of arrow-headed black spots, and beyond these a series of rounded spots, the first four encircled with white, the rest with pale brown; two broken, black discal lines,

filled-in with brown; a broad irregular band to below centre of wing, beyond cell, and formed of three black lines with brown interspaces; a triangular white spot below cell and a white patch terminating it and traversed by two black crosses; two diverging black bars surrounded with white in centre of cell, and a third surrounded with dirty testaceous near base; a large irregular patch of pale ochraceous or whitish brown below end of cell, bounded on internal area by three unequally formed patches which together almost form the sides of a large triangle; two small spots near base; hind wings greyish, becoming browner towards outer margin and crossed by eight interrupted black bars; body brown; length of wings about 5 in. 11 lines.

Art. XXXI.—*On the Spiders of New Zealand.* By Ll. Powell, M.D.

Part I. *Genus* Salticus.

(With Illustrations.)

[*Read before the Philosophical Institute of Canterbury, 1st May,* 1872.]

In the special department of Arachnology there is no modern systematic work; descriptions are scattered through the transactions of various societies, which are quite inaccessible to us at the antipodes; the differences between species are frequently so slight as to be described with great difficulty by a novice, and on the other hand some species vary in so remarkable a manner that there is great tendency to describe varieties as distinct species.

I would ask students of the various branches of entomology in New Zealand not to be deterred by these obstacles, but to follow my example and do their best, feeling confident that with practice and experience difficulties will be gradually overcome. Let all species believed to be new be described with the utmost minuteness, leaving the genera doubtful where doubt exists, and avoiding the creation of new genera likely to create present confusion and subsequently to be swept away. This is the plan which I intend to pursue in recording descriptions of New Zealand spiders, and I have every confidence that arachnologists of greater experience in other parts of the world will deal tenderly with my shortcomings, assisting me with their advice, and indicating points which are more particularly deserving of attention.

I would point out that there are many departments of natural history which are at present unnoticed, and it is greatly to be desired that members of this Society would take up single branches, collecting assiduously and describing carefully; in this way the study of natural history in New Zealand, will make rapid strides, and in this way alone.

W. L. Buller del. A. G. Buller Chromo-lith. Mintern Bros imp

PORINA MAIRI. *Buller.*

The spiders seem to be fairly represented in this country. My collecting has been performed in a very desultory manner on occasional holidays, and has been confined almost entirely to the neighbourhood of Christchurch. I have now in my possession specimens belonging to over sixty species of more than twenty genera. The number of genera is very large in proportion to the number of species, and affords an indication of the very wide field which lies open to the collector.

Genus *Salticus*, Latreille.

Pl. XIX.

Eyes disposed in three rows, constituting three sides of a square, in front and on the sides of the cephalo-thorax; the two intermediate eyes of the anterior row are the largest, and the intermediate eye of each lateral row is much the smallest of the eight, maxillæ short, straight, enlarged at the base, where the palpi are inserted, and at the extremity which is rounded; lip oval, obtuse at the apex, legs robust, varying considerably in their relative length in different species.

Of the genus *Salticus*, a very numerous genus in all parts of the world, I have eight species, which are, I believe, undescribed. Of seven of these I append minute descriptions, the eighth is a solitary immature specimen which I shall not at present describe.

1. SALTICUS APPRESSUS, n.s. Fig. 1.

Length ·8 inch.

Cephalo-thorax oblong, body remarkably flattened or depressed, nearly quadrilateral, about twice as long as broad; caput scarcely defined from the thorax, exceedingly flat; eyes of middle row rather nearer anterior laterals than posterior row; thorax about two and a half times as long as caput.

Colour in some specimens uniform grey, produced by a coat of close short grey hair on a black ground. In adult males longitudinal black stripes on the grey ground, varying much in distinctness.

Legs, order of length, 4, 1, 2, 3; fourth pair rather long and slender. First pair very broad, flattened out, especially the femoral joint; second pair robust and flattened, but far less so than first pair; third pair far the smallest and slenderest. Colour brownish grey, clothed with short grey hair.

Palpi not very large or long; palpal organ tumid, with a slightly curved short filament at extremity; a strongish slightly crooked spine on outer aspect of radial joint; radial and digital joints clothed with long greyish hairs.

Falces most remarkably small, corresponding in width to anterior middle pair of eyes, and no deeper than they are broad, inclined forwards.

Maxillæ small, slightly inclined towards lip, dilated at extremity. Lip oval, rather longer than broad.

Sternum a long oval, rather sunk between the coxal joints of the legs.

Abdomen flat, a long oval twice as long as cephalo-thorax, with two longitudinal creases or striæ; either uniform grey in colour, from having a thick coat of short grey hairs on a blackish surface, or denuded in places of hair so as to leave a black pattern consisting of a broad black band, extending half the length of the abdomen and terminating in three black lines, extending to the spinnerets. Towards the spinnerets on either side a couple of oblique black marks tending forwards towards the middle line; under surface black; vulval opening simple.

The habits of this remarkable spider might be predicted from its form. It inhabits chinks and crevices, into which it sidles with great dexterity when alarmed. Its singular flattened form, as if it had been trodden underfoot, and its small inconspicuous falces, peculiarly adapt it to its favourite habitat. I have never seen it apart from palings or human habitations, never in the bush nor away from the neighbourhood of the town, although one would expect to find it like *Delena*, beneath the detached bark of trees. I have, however, never seen it in this situation.

Found on palings in and around Christchurch.

2. Salticus minax, n.s. Fig. 2.

Length, ·5 inch.

Cephalo-thorax oval, truncated anteriorly, two-thirds as long again as broad, ·2 in. long; lateral borders convex, a slight depression behind caput; normal grooves rather obscure.

Colour rich blackish brown, becoming quite black at the lateral borders, an obscure mahogany-coloured stripe down the centre, surface polished.

Eyes, three rows; middle pair of anterior row far the largest; middle pair decidedly nearer to anterior laterals than to posterior pair.

Legs, 1, 4, 2, 3; anterior legs very robust and powerful, black, with strong spines on trochanteric libral and metatarsal joints, clothed with hairs; tarsus red brown; three posterior pairs comparatively slight and weak, dark honey colour; all the tarsi with a blackish scopula; length of anterior leg four-fifths of an inch in female, half an inch in male.

Palpi not very large, rather long; palpal organ tumid, a short very slightly curved filament at extremity; a small simple spine on outer side of radial joint, also a few long curved hairs.

Falces tumid, robust, black, with a strong brown black claw. In the male an abrupt projecting process about the middle of the fang. A few strong teeth on inner aspect of falx.

Maxillæ long, divergent, inner border very convex; a rather acute angle at junction of anterior and outer borders. Lip long oval, truncated anteriorly. All dark mahogany brown.

Sternum oval, nearly black.

Abdomen a long oval or cylindrical, tapering towards extremity, about three-fifths of an inch long. Colour dull olive green or greenish brown, with a striking pale greenish or greenish yellow stripe down the centre; normal pits generally well marked; under surface a dark stripe down the centre with pale borders.

Vulva not very conspicuous.

Favourite habitat—the dead leaves clothing the trunk of the cabbage-tree (*Cordyline*).

Riccarton Bush, Governor Bay and North Island.

3. SALTICUS ATRATUS, n.s. Fig. 3.

Length ·3 inch, male the largest.

Cephalo-thorax oblong, fully half as long again as broad, lateral borders convex; rather abruptly sloped posteriorly; a well marked transverse depression behind caput; thorax rather longer than caput. Colour brilliant black, with pinkish metallic reflections, especially on caput; a few blackish hairs sparsely distributed, especially at anterior border, a few white hairs bordering sides of caput.

Eyes, middle row very nearly equidistant from anterior laterals, and posterior row very slightly nearer the former.

Legs rather long and slender; order of length, 1, 3, 4, 2; first pair considerably longest and stoutest; not much difference between third and fourth. Colour of legs black, with a brownish tinge, tarsus reddish brown; legs clothed with fine black hairs, a few greyish hairs on two posterior pairs.

Palpi not very long or large. Radial joint small and concealed on anterior aspect, a small curved, slightly crooked, spine on outer side; both cubital and radial joints provided with long coarse curved hairs.

Palpal organ pear-shaped, a coarse blackish brown filament at distal extremity; taper extremity of the pear-shaped organ projects so as to hide the radial joint.

Falces small, conical, dark red brown; fangs small and weak.

Sternum a narrow oval.

Maxillæ dilated and rounded at extremity; lightish brown.

Under surface dull brown; coxæ light olive brown; legs and abdomen rather thickly clothed with greyish hairs.

Abdomen slightly longer than cephalo-thorax, a rather broad oval pointed posteriorly. Ground colour black, bordered anteriorly with a band of white hairs; three not very well defined oblique bands of white hairs on either side, and some obscure markings of a similar nature above the spinners. Surface glossy, sparsely coated with black hairs, especially towards posterior extremity.

In the smaller adult male in my possession the white markings are scarcely distinguishable. The immature specimens are clothed throughout with short greyish hair, the markings being very obscure.

Taken on rocks at Sumner. Two adult specimens; of males, several immature specimens.

4. Salticus V-notatus, n.s. Fig. 4.

Mature male.

Length ·25 inch nearly.

Cephalo-thorax oblong, somewhat elongate, raised, slopes rather abruptly posteriorly, and projects well forward over the falces; brownish black, with a few light yellowish hairs along the lateral eyes; middle row of eyes about midway between anterior laterals and posterior pair.

Legs, 1, 4, 2, 3; first and fourth not differing much in length; legs not very robust, but first and second more so than third and fourth; brownish black, sparsely clothed with longish hairs.

Palpi—palpal organ pyriform, apex overhanging and concealing radial joint; at distal extremity a coarse blackish brown filament, curved like a ram's horn; radial joint has on outer aspect a crooked simple spine. Radial and digital joints clothed with longish white hairs.

Falces cylindrical small.

Maxillæ robust, rounded internally, forming an acute angle at junction of anterior and external borders; lightish brown: lip conical.

Abdomen oval, pointed posteriorly; a broad black band down centre, dividing into three posteriorly, and inclosing a yellowish V shaped mark; sides irregularly marked with yellowish hairs; under surface yellowish grey, bordered with black.

A single specimen taken on Oxford Terrace, Christchurch.

5. Salticus fumosus, n.s. Fig. 6.

Length ·8 in.

Cephalo-thorax semi-oval, abruptly truncated anteriorly; lateral borders very nearly straight for anterior two-thirds of their length; cephalo-thorax deep, flattened above and sloping away posteriorly; a slight transverse depression behind caput; colour dark brown; short red hairs fringe the anterior border above and around the eyes.

Eyes, lateral eyes form a straight line; posterior eyes not quite midway from anterior border to posterior border of cephalo-thorax; middle row of eyes about midway from anterior laterals to posterior row.

Legs, female 4, 1, 2, 3, male 1, 4, 2, 3, but scarcely any appreciable difference between fourth and first in female; first pair robust, dark blackish

brown; strong spines on trochanteric libral and metatarsal joints; three posterior pairs yellowish brown; second pair most robust and darkest of the three, and provided with strongest spines. Feet provided with a blackish scopula.

Palpi rather long; palpal organ tumid, simple in structure, no filament perceptible. Radial joint provided with a strong curved spine on outer side and long coarse curved hairs; digital joint clothed with coarse hair. All dark brown.

Falces small and short, not occupying much more breadth than the anterior pair of eyes; red brown.

Maxillæ slightly divergent, rounded at exterior angle; lip abruptly truncated.

Sternum a long oval, yellowish brown.

Abdomen ovoid, pointed posteriorly; upper surface dull sooty brown or bistre colour; a broad pale band runs down the dorsum with a double darker line in the centre, interrupted at about a fourth of the distance by two minute oval pale spots, the whole obscurely striated by oblique lines. These markings are all very obscure.

Under surface rather pale, and marked longitudinally by three dark lines originating near the generative pore and converging posteriorly.

Vulva reddish brown, not conspicuous.

Favourite habitat—dead leaves clothing the trunk of the cabbage-tree (*Cordyline*), Riccarton Bush. Abundant.

6. SALTICUS MUSTILINUS, n.s. Fig. 7.

Length, ·25 inch.

Cephalo-thorax oval, truncated anteriorly, deep, sloped abruptly posteriorly, overhanging the falces, no perceptible grooves. Colour, between the eyes mahogany brown, with a lighter patch on the inner side of each posterior eye, a similar pale band down the centre of the thorax, anterior border of caput fringed with coarse yellowish white hairs, thorax sooty brown, with a palish band down the centre, and sometimes a bordering line of whitish hairs.

Legs, 1, 4, 3, 2; first pair far the most robust, dark reddish brown, except the femoral joint, which is paler; other legs honey colour; second and third not differing much in length.

Palpi rather long; palpal organ oval, proximal end concealing radial joint, at distal extremity a short slightly curved dark brown filament; on outer side of radial joint a short dark slightly curved spine.

Falces long and powerful, conical, dark brown; claw strong and curved, with two slight projections on outer aspect, one small tooth on inner aspect.

Maxillæ straight, rounded internally, forming a rather acute angle at

junction of anterior and outer borders; lip truncated, rather longer than broad, dark red brown.

Sternum oval, pale and brown.

Abdomen a long oval, pointed posteriorly, down the centre runs a reddish toothed band containing a sooty longitudinal mark vandyked or formed by confluent lozenges, on either side of the reddish band a sooty stripe bordered by pale yellowish white hairs. Under surface pale yellowish, with three longitudinal dark lines.

Riccarton bush; on shrubs.

7. SALTICUS ALBOBARBATUS, n.s. Fig. 8.

Length of mature male, ·25 inch.

Cephalo-thorax oblong, sloping forwards anteriorly, sloping away abruptly posteriorly; sides very slightly convex, glossy black, slightly iridescent, and sparsely clothed with coarsish black hairs.

Eyes, three rows; anterior middle pair far the largest. eyes of second row very small midway between anterior and posterior rows. Beneath the anterior row of eyes is a remarkable beard-like growth of pure white hair, converging from the sides towards the middle line, and contrasting strongly with the glossy black which is the prevailing colour of the spider; this beard nearly conceals the falces.

Abdomen ovoid, rather pointed posteriorly. Colour glossy black.

Legs, 4, 3, 1, 2; not very robust; black, becoming brownish towards distal segments. A black scopula terminates the tarsi; all the legs are sparsely clothed with black and whitish hairs.

Having only dried male specimens I am unable to give further particulars with accuracy.

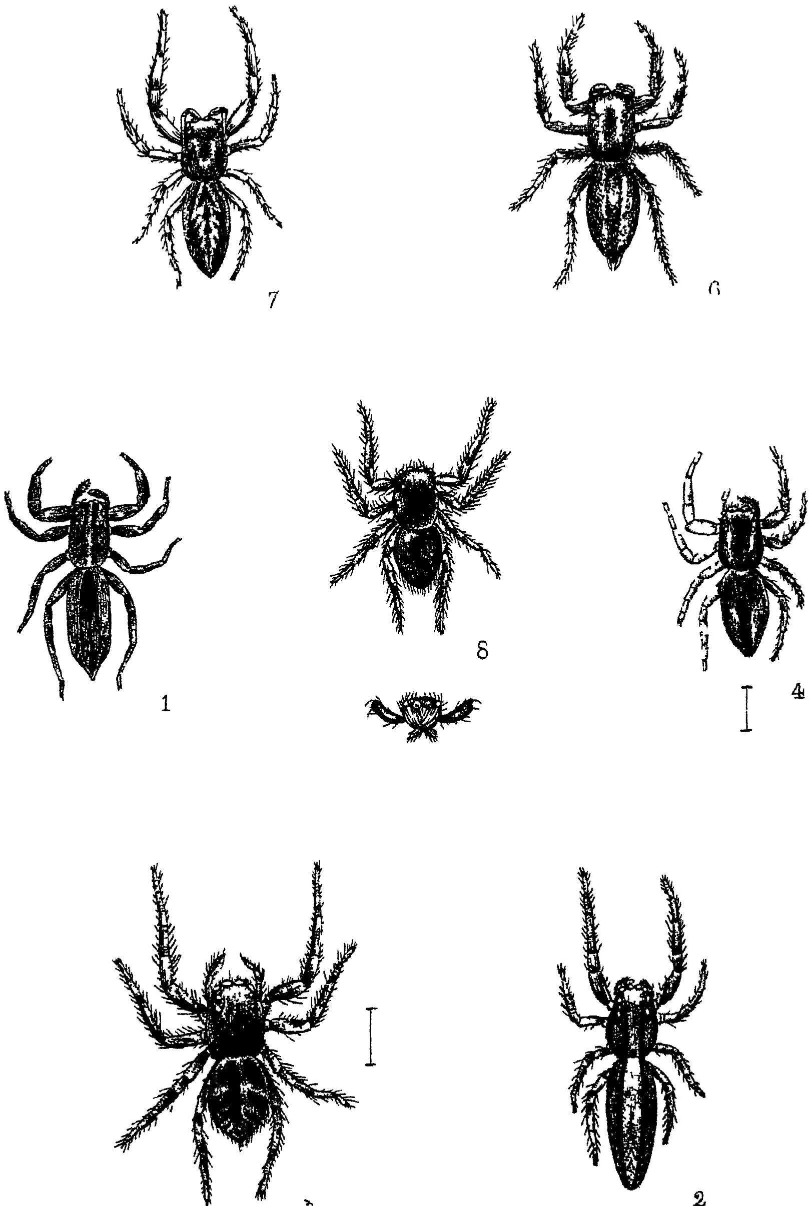
Habitat, shingle slides. Castle Hill; collected by J. D. Enys, Esq.

ART. XXXII.—*Notes on the Stridulating Organs of the Cicada.* By LL. POWELL, M.D.

(With Illustrations.)

[*Read before the Philosophical Institute of Canterbury, 1st May, 1872.*]

AT page 351 of "The Descent of Man" (1871) I find the following statement:—"The *Cicadidæ* usually sing during the day, whilst the *Fulgoridæ* appear to be night-songsters. The sound, according to Landois, who has recently studied the subject, is produced by the vibration of the lips of the spiracles which are set into motion by a current of air emitted from the tracheæ. It is increased by a wonderfully complex resounding apparatus,



N Z SPIDERS.
Genus *SALTICUS* Latr

Ll Powell del JB lith

consisting of two cavities covered by scales. Hence the sound may truly be called a voice. In the female the musical apparatus is present, but very much less developed than in the male, and is never used for producing sound."

As I have not access to Landois' original paper I am, of course, ignorant of the details of his description, but unless the cicada which he describes differs essentially in the nature of its musical organs from those found in New Zealand, and also from those described more or less correctly by other authors, especially Reaumur (see Kirby and Spence's "Introduction," p. 501, seventh edition, 1856), he is most certainly in error.

The stridulating organs of the cicada (Pl. XVIII.) are constructed on a principle which is, I believe, unique. In no other animal, as far as I am aware, are vibrating membranes made use of for the purpose of producing sound, and in this respect they possess a peculiar interest. In the male cicada on the upper surface of the first ring of the abdomen on either side may be seen a semilunar opening with convexity posterior, and on examining this opening with a magnifying glass it will be seen to lead into a shallow cavity closed in by a plicated horny membrane. If a live insect be caught and these membranes be observed during the act of stridulation they will be seen to be vibrating rapidly, synchronously with the beats of the shrill sound. On examining the under surface of the insect an oval plate will be observed immediately behind each posterior leg, of considerable size, and quite free except anteriorly. On snipping off these plates with a fine-pointed pair of scissors we expose on each side a large triangular opening, the apices opposed to one another, and but slightly separated; each opening leads into a roof-shaped cavity of considerable extent. Anteriorly this cavity is closed in by a fragile but opaque membrane divided into two parts by a chelinous rib, the lower half is pure white and marked with parallel creases, the upper half is yellow and tougher looking; posteriorly the cavity is closed by a large tense beautifully transparent membrane, it is very delicate and shines with iridescent colours; it is marked *dr* in the illustration. If we now carefully cut the body through anteriorly to the membranes here described, and to the stridulating membranes, by a little careful dissection we shall expose the immediate agent of the production of the sound, and see two thick yellow bundles of muscle inserted below into the parietes of the abdomen at the junction of the cavitary membranes. These muscular bundles diverge like the letter V, a delicate aponeurosis is given off from each muscle, which seems to be lost on the rim of the transparent membrane; the muscle itself ends in a round tendon which is inserted into the under surface of the stridulating membrane. This membrane is highly elastic, and the sound is produced by the contraction of the muscle straightening out the plications of the membrane; this produces a click, and, on the muscle relaxing, the membrane from its elasticity springs back with

another click. That this is really the mode in which the sounds are caused may be proved by exposing the parts immediately after killing the insect; on then allowing the muscles to harden a little by exposure, and on pulling them with the point of a pin, the membranes will be seen to straighten and fly back again, accompanied by the production of the usual sound.

Now what part do the large transparent drum-like membranes take in the production of the sound? All writers on the subject have attributed to them reverberating qualities for the intensifying of the sound, but a simple experiment appears to disprove this, for if an insect be taken while stridulating and all four of the membranes be destroyed with a pin the sounds are not materially affected, but if one of the stridulating membranes be destroyed the sounds suffer great diminution, and on destroying the other they cease entirely. I was much surprised the first time I tried the experiment to find that the large drums seemed to take no part in the production of the sound, and the idea occurred to me that they might be hearing organs, but on examining the females, which, most remarkable to relate, are dumb and do not possess the stridulating organs, I found that the drums exist indeed, but are quite rudimentary instead of being large as we should expect to find them were they subservient to the sense of hearing. The question remains then of what use are they? That such highly developed structures must be of some use is clear. The three cicadæ found commonly in Canterbury differ in the sounds produced. The small green cicada utters a sound which may be represented by the repetition of the letter "r" thus "r-r-r-r-r-r," the voice of the larger green species would be expressed by "crrrk–crrrk–crrrk," while the small black ones found in the hills say "crrrk-r-r-r-r-r." The voice of this species is remarkably loud and piercing.

In connection with the voice of the cicada I may allude to a circumstance which has been frequently observed, viz., inability of some individuals to perceive very acute sounds. This is very noticeable with the song of the small green cicada. I have found many persons who are totally unable to hear any sound when my ears are being pierced with their shrill voices so as almost to give rise to a feeling of pain. There would seem to be in some cases less a deficiency in the organisation of the ear than in the faculty of perception, which is akin to the difficulty experienced by a landsman in perceiving very distant objects at sea. In some individuals, however, there is an absolute inability to hear very acute sounds, and inasmuch as the entire range of the human ear is, according to Helmholtz, eleven octaves, it has been justly remarked that the air may be filled with shrill insect sounds, which may be perfectly audible to the insects themselves but absolutely inaudible to our grosser sense.

ART. XXXIII.—*On the direct Injuries to Vegetation in New Zealand by various Insects, especially with reference to Larvæ of Moths and Beetles feeding upon the Field Crops; and the Expediency of introducing Insectivorous Birds as a Remedy.* By R. W. FEREDAY, C.M.E.S.L.

[*Read before the Philosophical Institute of Canterbury, 12th December,* 1872.]

THE little time and attention that I have been able to afford to its investigation precludes my treating exhaustively a subject so comprehensive as that of Injuries caused by Insects, and Benefits derived from Insectivorous Animals; but, should the members of the Society be sufficiently interested, I hope, on some future occasion, to enlarge upon the subject in a series of papers.

It has been observed by the authors of a valuable work on entomology, that if it were not for certain counter-checks restraining them within due limits, insects would drive mankind, and all the larger animals, from the face of the earth.—That "the common good of this terraqueous globe requires that all things endowed with vegetable, or animal life, should bear certain proportions to each other, and if any individual species exceeds that proportion it becomes noxious, and interferes with the general welfare." And they ask, "How is it that the Great Being of beings preserves the system, which he has created, from permanent injury in consequence of the too great redundancy of any individual species, but by employing one creature to prey upon another, and so overruling and directing the instincts of all that they may operate most where they are most wanted."

So long as this balance remains undisturbed, so long will harmony prevail; and whenever we suffer excessive injuries from insects, or other animals, the cause may generally, if not invariably, be traced either directly or indirectly to the agency of man alone. Man, in his blindness, is ever breaking, or throwing out of gear, some wheel of the great cosmical machine, and disorder necessarily follows.

In illustration of this, I would point to the great increase of caterpillars, and other larvæ, in the neighbourhood of Christchurch during the last four or five years—an increase attributable in all probability to the following simple causes:—

In the early days of the Canterbury settlement, quails, larks, and other birds that fed upon insects and their larvæ, abounded on the plains; but the quails have been exterminated, the larks have become comparatively scarce, and the other birds have almost disappeared. So long as the plains remained open and uncultivated, extensive grass-fires sweeping over the land consumed an enormous amount of insect life, and took the place of that counter-check which was being removed by the decrease of the birds; but within the last

few years inclosures and cultivation have been rapidly extending around Christchurch, and forming a nursery for the preservation and increase of the insect race. A luxuriant and abundant vegetation has sprung up for its food and shelter, and it is comparatively freed from the ravages of fire and the attack of its feathered foes. What can we expect under such circumstances but to be visited with an insect pest? Unless some remedy were applied, or some special intervention of Providence occurred, the evil would inevitably increase with each succeeding year, and the farmer would ultimately find that his money and labour were providing but a harvest for the caterpillar and grub.

Some idea may be formed of the enormous increase of herbivorous insects if we take. for example, *Plusia gamma*, one of the moths of the *Noctuæ* family (a family extensively represented in this neighbourhood) and the common *Aphis* or plant louse. Réaumer has proved that from a single pair of *Plusia gamma* moths, 80,000 might be produced in one season, and the rapidity of production of the *Aphidæ* is so enormous, that nine generations have been produced in three months; and, each generation averaging 100 individuals, it has been calculated that 10,000 million millions may be generated in that period from a single *Aphis.*

So far as I have been able to ascertain, from inquiry and from my own personal observations, the insects which appear to have been the most injurious to the farmers of this neighbourhood are of the following kinds, namely :—

Of moths five species, namely—*Pielus umbraculatus*, Gu., *Pielus variolaris,* Gu., and *Cloantha composita,* Gu., (all named and described by M. Guenèe as "new species" from specimens taken by me in this province), and *Heliothis armigera* and *Sesia tipuliformis* (a species found also in England).

Of Beetles two species, namely — *Odontria striata* and *Odontria* (n.s. undescribed).

Of Aphides, several species.

Several specimens of the perfect insect of each of the above species of moths and beetles I now place before you for inspection, and in order that you may identify the species to which I allude.

Pielus umbraculatus and *P. variolaris* make their appearance on the wing, in great numbers, in the evening twilight, and in the daytime are found at rest on posts and rails and palings and such like places, and numbers may be seen entangled or wound up in the webs of spiders. These moths are very abundant in the months of October and November. The family to which they belong has received the common name of "swifts" from the rapidity of their flight. The larvæ of these species are short fleshy grubs, having six pectoral, eight ventral, and two anal feet; they are subterranean, and feed

principally upon the roots of grasses, coiling themselves up when disturbed. The transformation to the pupa state takes place under ground, and the pupæ are of a chestnut colour and glossy.

Cloantha composita not only flies at night, but also may be frequently seen on the wing in the daytime, flying briskly from flower to flower, and feeding upon the nectar, which it extracts with its long proboscis. The larvæ are more slender than those of *Pielus*, of a variety of colours, and striped longitudinally with numerous thread-like lines. They have sixteen feet, and feed principally on grasses and standing corn—especially rye-grass and oats—eating off the heads and stems of the grass, and the ears and leaves of the corn, sometimes resting on the stems during the day, but generally hiding in the grass, and coming out at night to feed. They commit immense damage, and when they have consumed the grass of one field they may be seen in prodigious numbers marching over the ground to another. The pupa is found under ground, and is of a dark glossy chestnut colour.

Heliothis armigera makes its appearance on the wing by day, as well as at night, and particularly delights in the brightest sunshine, when it may be seen, like *Cloantha composita*, flying about the flowers in search of nectar. The caterpillars are of various colours, have sixteen legs, and feed on low plants and vegetables, particularly peas, the pods of which they perforate and devour the contents. The colour of the pupa is glossy chestnut or brown.

Sesia tipuliformis has undoubtedly been brought into this country with the currant tree, upon which it feeds, and it shows how careful we ought to be when introducing anything useful that we bring not with it a grievous pest. The ravages of this insect have so increased that I question if we shall be able much longer to grow the red currant unless some check is imposed. The larvæ (whitish fleshy grubs) perforate the stems and branches of the trees, and eat away the pith. The perfect insect would be mistaken by the uninstructed for a species of fly or hymenopterous insect, so little does it resemble the ordinary appearance of a moth.

The *Odontria* beetles may be seen in the dusk of evening, flying in swarms over the grass, and humming like a hive of bees. The larvæ are subterranean, and are particularly destructive to clover and grasses, devouring the roots and leaving the upper part of the plant loose upon the ground as if cut off with a knife. They are soft fleshy grubs of a whitish colour, with brown horny heads. They have six legs, one pair on each of the three first segments, but none on the hinder. When disturbed they lie motionless, in a recurved position, having the hinder part bent inwards towards the head in the form of a hook. They seem, though not half their size, to be almost as destructive as the larvæ of the cockchafer (*Melolontha vulgaris*) which does such immense damage to pastures in England. Most, if not all, of the several species of this

family continue in the larva state for several years before transformation to the pupa, and it is probable that such is the case with the two species we are now considering. The perfect insect feeds upon the leaves of various trees, but I do not think that any serious injury in that respect has yet occurred in this province. Dr. Carpenter, in his work on zoology, revised by Mr. Dallas, referring to the cockchafers, says, "Their excessive multiplication is usually prevented by birds; but if these be kept away they increase very rapidly and become a complete pest to the cultivator. The perfect insects sometimes make their appearance in such swarms as to devastate an entire forest."

A species of *Aphis* appears to have become very injurious to our corn crops, and we all know what pests we have in two other species, the one *Aphis lanigera*, commonly called "American blight," which infests the apple trees, and the other the "cabbage blight."

In addition to moths, beetles, and *Aphides* I may mention locusts and grasshoppers, the latter of which are very abundant on the plains, and devour a considerable quantity of grass and herbage. Fortunately for us the locusts are not yet so numerous as to do any considerable mischief, but I have noticed their increase of late years. These insects are so well known in their perfect state that I may pass over them with the single remark that their larvæ and pupæ resemble the perfect insects, except that the wings of the pupæ are rudimentary only and the larvæ have none.

There is also a most destructive species of saw-fly, identical either with *Selandria cerasi*, or the North-American "slug-worm," or closely allied thereto. The larva of this fly is covered with a greenish-black viscid matter which exudes from its body, and to a cursory observer resembles a small black slug. It feeds upon the upper surface of the leaves of its food plant. Cherry, plum. pear, hawthorn, and sometimes other trees, become completely stripped of their leaves by these larvæ, and when it occurs early in the summer, as it frequently does, the trees are compelled to put forth fresh foliage, thereby weakening them, and lessening the production of fruit in the succeeding year.

Lastly, there is an insect which appears identical with, or allied to, *Coccus arborum linearis.* It infests the pear and ash, and some other trees, and has the appearance of a small scale shaped like a mussel-shell. These insects thickly cover the bark of the trees, to which they closely adhere and exhaust the sap.

Such as I have above described are, I believe, the most injurious of the insects we have to contend with, but there are numerous others of minor importance that I must defer for future observation.

We will now proceed to the consideration of the expediency of introducing insectivorous birds and animals as a remedy.

The increase of insects is so enormous and rapid, and their location so

intimately connected with the things they destroy, that we cannot effectually apply any direct remedy, without at the same time destroying or injuring what we attempt to preserve. It is an error to suppose that caterpillars, or the larvæ of insects, are to any considerable extent affected by atmospheric forces. The severest frost does not destroy their vitality, for if they fail to find a sufficient shelter torpidity only is produced. I have myself taken caterpillars from the snow so entirely frozen as to have become brittle as glass, and yet, when exposed to the warmth, they have quickly revived and resumed their activity, without having suffered any apparent injury. When inundations or heavy falls of rain take place, and the ground becomes completely covered with water for days or weeks, considerable mortality is probably caused amongst the caterpillars; but such occurrences are only occasional and local.

Our only remedy is an indirect one, and that I conceive to be the employment of insectivorous animals to do the work for us; and for this purpose insectivorous birds stand prominent. I consider it to be our duty not only to protect the few indigenous birds that yet remain, but to continue to introduce others, until we have restored the balance which has been disturbed.

Of indigenous insectivorous and insect-destroying animals already existing in this locality, the following list, I think, comprises most of those which are of prominent importance, namely:—

Bats—entirely insectivorous, and of which, I believe, we have more than one species, but the individuals do not appear to be very numerous.

Gulls and terns, or sea-swallows—visiting the fields in flocks, and picking up slugs, worms, and grubs.

Larks—of which we have one species only—and a few small birds seen in the bush, and in our gardens.

We have also the *Zosterops*, commonly called "blight-birds," from their feeding on the American blight (*Aphis lanigera*), but they, though there is no direct evidence of their introduction, are considered not indigenous.

Lizards, spiders, dragon-flies, which are all entirely insectivorous.

Beetles, of which we have numerous species of the *Carabidæ* family, whose habit is (to use the words of Dr. Carpenter) "to prowl about on the surface of the ground, under stones, etc., beneath the bark of trees or moss growing upon their roots, in search of their insect prey, which consists chiefly of herbivorous species of their own order. Some of them nocturnal in their habits, feeding on cockchafers and other species of herbivorous beetles that fly abroad during the night." And two species at least of the family of the *Coccinellidæ*, commonly called "lady-birds," or "lady-cows," whose larvæ feed entirely upon *Aphides*.

Flies—of which we have two species most destructive to moths and flies, namely, *Asilus varius*, and *Doctria*, (? species) which dart from their resting place with exceeding rapidity, and seize their prey on the wing.

Ichneumons — a tribe of parasitic insects the most valuable of all, for scarcely an insect exists that is not exposed to the attack of one species or another of them. Every species of ichneumon has its particular species of insect upon which its larvæ exist. The victim is generally the larva (in some cases the egg or pupa) of some other insect. The egg of the parasite having been deposited by means of a long ovipositor, and hatched in the body of its victim, the parasite grub there feeds upon it, for days and months, devouring all but the vital organs; and so accurately is the supply of food proportioned to the demand that the victim lives just long enough for the parasitic grub to become full-fed and ready to assume the pupa state.

I have now only to indicate what birds are most valuable for us to introduce and acclimatize.

Thanks to our Acclimatization Society, many useful birds have already been introduced, and thoroughly established. Pheasants, sparrows, and chaffinches are plentiful; and many other birds (included in the list below), though at present scarce, seem to have obtained a firm footing.

To enumerate all the useful birds it is desirable to introduce would occupy more space than can be afforded in this paper, and I, therefore, confine myself to suggesting the few I have named in the list below; and, in selecting from such list, it should be a matter for consideration what species will increase the most rapidly, and spread over the country; and it should be borne in mind that many of the birds which live entirely on insect food are less valuable, for the purposes for which we require them, than others not wholly insectivorous, and that gregarious birds are preferable to those comparatively solitary.

The following is the list of birds recommended as insectivorous in their habits:—Rooks, jackdaws, partridges, landrails, starlings, skylarks, quails, plovers, redpolls, swallows, martens, swifts, blackbirds, thrushes, pipits, wagtails, nightingales, tits and their allied species, and wrens.

Art. XXXIV.—*Remarks on the* Coleoptera *of Canterbury, New Zealand.*

By C. M. Wakefield.

[*Read before the Philosophical Institute of Canterbury, 4th September,* 1872.]

Before commencing my brief review of the *Coleoptera* of this province I trust I may be permitted to make a few observations upon the difficulties which beset the entomological student in New Zealand, and upon the means by which in my opinion they may be obviated. For several years I have taken much interest in the beetles of this colony, and have collected them so far as my avocations would permit. At every step of my inquiry, however, I have been met and thwarted by an obstacle which I apprehend is familiar to all

those who have commenced to study any branch of zoological science in a new country. I allude to the extreme difficulty, nay, almost impossibility, of ascertaining with precision what has been written upon its fauna, and which of its species have been described by European authors. Anyone who attempts to describe those animals which he conceives to be new without possessing this knowledge is certain not only to fall into many errors, but, by the creation of unnecessary synonyms, to cause much confusion and to obstruct rather than forward the cause of science.

All those who are acquainted with the uncertainty which already exists in scientific nomenclature, must be aware that persistence in such a course would speedily reduce zoological literature to a perfect chaos. Mr. M'Lachlan, the eminent neuropterist, in alluding to this subject says, in substance, as follows:—"I conceive anyone to be guilty of a high crime against science who describes a species as new without first endeavouring, by every possible means, to ascertain whether it has already been described or not." In Canterbury, however, our museums and libraries are, or were till very recently, so miserably provided that it has been impossible for a collector whose business confined him to the province to acquire this necessary information. When we reflect upon the number of our colonists who have been so fortunate as to revisit Europe, when we consider that many of them have been men of wealth and influence, and, what is more to the purpose, when we recollect that many of them have been sent home at the public expense and have drawn liberal salaries from the public purse whilst in England, it must be a matter of astonishment that scarcely any one of them should have devoted a very small portion of his money and leisure to the purpose of providing the naturalists of this province with the necessary means for pursuing their studies. Miscellaneous contributions of all kinds are arriving at our museum, and I fully admit their beauty and value, but what the practical naturalist requires is *a small collection, consisting of duplicates of all the New Zealand species existing in the museums of Europe.* I fear it will be some time before we possess this desideratum. Indeed, it was only about two months ago that we heard that a copy of the "Zoology of the Voyage of H.M.S. 'Erebus' and 'Terror'" was at length on its way to Christchurch. As this work may be considered the foundation stone of New Zealand natural history I shall venture to make a short digression concerning it.

When the "Erebus" and "Terror" returned home, about 1843, Parliament voted, I believe, £4,000 towards the publication of the results of the voyage. Of this sum, £2,000 was devoted to botany, and a like sum to zoology. In due course Dr. Hooker produced the portion assigned to him in the shape of that excellent work upon the flora of New Zealand, with which we have been long familiar, and with which our libraries are pretty well provided. For

some mysterious reason, however, the "zoology" was never regularly published, and I believe that a single copy never found its way to this province. At any rate, I have made repeated inquiries and could never ascertain the existence of one here, though there may be some in the other provinces. Considering that this costly work was published at the imperial expense, with the intention of diffusing as widely as possible the information acquired during the voyage, it must betoken either great stinginess on the part of scientific authorities at home or great apathy on the part of those here, that we should have remained for so many years without a copy of it. Of course, a great many additional New Zealand species of *Coleoptera* have been described since 1846, but to give you some idea of the difficulty of tracing them, I may mention that some of our beetles have found their way into the hands of a Russian entomologist and that, owing to the unfortunate disuse of Latin, and the mania for "modern languages" which are now so fashionable, he has actually described them in Russian! Well might the president of the Entomological Society of London remark, in one of his recent addresses, "that if the practice of recording scientific information exclusively in the vernacular be persisted in, the thorough investigation of any family of insects, already extremely difficult, will soon become totally impossible." Books alone, however, are not all that the working student requires, and having been long convinced of the necessity of procuring for the province such a typical collection as I have alluded to, I some years ago endeavoured to supply one for this purpose.

I took with me when returning to England as good a collection of our insects as somewhat adverse circumstances had enabled me to get together. I intended to have had these properly named and classified in London, to have compared them with the types in the British Museum, and to have then sent them back to the colony. Unfortunately, this small collection was lost when the "Blue Jacket" was burnt, and all my efforts to replace it, by inducing my New Zealand friends to forward me specimens whilst in England, proved, with one exception, quite unavailing. Thus, although I was ready to devote a considerable portion of my time, and to incur not a little trouble and expense in order to provide a working collection of insects for our museum, I was unable to do anything for want of the necessary material, and was compelled to return to New Zealand almost as ignorant of its desciiptive entomology as I left it. Labouring under such great disadvantages, I should not venture to lay the following remarks before you, had I not observed since my return a lamentable dearth of original papers in our Society; and had I not also noticed that a meagre and imperfect paper often has the effect of eliciting valuable information from those who possess it.

The poverty of the New Zealand fauna is well known, and the order *Coleoptera* affords but few exceptions to the general rule. Our beetles are

generally small and inconspicuous, and are, on the whole, greatly inferior to those of Britain. This comparison will appear all the more striking when we reflect that Great Britain itself does not possess more than half the number of species contained in an equal area of the continent of Europe, and it is almost needless to observe that Europe is greatly excelled in this respect by Asia, Africa, and America. Indeed, a Swiss entomologist once remarked to me that after collecting in his own country nature appeared to be dead in England, and from my own experience of European collecting I am able to indorse his statement. Three thousand species of *Coleoptera* have been found in Great Britain, and, although I cannot say precisely how many New Zealand species have been described, yet I do not think the number can possibly exceed five hundred. When, therefore, we consider what a diversity of climate and surface these islands present, it is obvious that there is ample scope for further investigation. Not only are our species few in number, but the individuals composing them are small and inconspicuous, and singularly destitute of brilliant colouring. The same dull and sombre hue so characteristic of the vegetation of New Zealand extends itself, with but few exceptions, to its fauna. The collector will vainly search here for those splendid metallic colours for which this order of insects is so celebrated, and which are unrivalled throughout the whole range of creation. Indeed, I only know of one finely coloured beetle in this province. I allude to the *Pyronota festiva* of Fabricius, which is so extremely common in our gardens and orchards, where it often does considerable damage. This is a pretty little insect no doubt, but how poor does it appear in comparison with the brilliant genera *Cetonia, Gnorimus, Trichius, Aromia, Chrysomela,* and *Donacia,* which are so familiar to the British collector.

Commencing with the *Cicindelidæ,* a family which, on account of the perfection of its organisation, was justly placed by Linnæus at the head of the whole order, we shall find that New Zealand is well represented. Five species occur in Britain, and of these only one can be called common, the others being exceedingly local. These islands possess certainly five, and probably six species, viz. : *C. tuberculata, C. douei, C. late-cincta, C. parryi* and *C. feredayi,* the last named by Mr. Bates from a specimen sent to him by one of our members. There is also another species which Mr. Bates hesitates at present to consider as distinct. I have only taken myself *C. tuberculata* and *C. late-cincta* in this island. *C. feredayi* is apparently very rare, and Mr. Fereday does not possess a duplicate. The other species appear to be confined to the North Island. The habits of *Cicindela* are well known. From their beauty and ferocity they have been appropriately named "tiger-beetles." As an instance of the utter insufficiency of popular language to discriminate even the widest marks of distinction between insects, and of the consequent

necessity which exists for a latin classification, I may mention that in Wellington these beetles are generally called, absurdly enough, "New Zealand bees." The larva inhabits deep burrows excavated in the sand, and almost every steep bank in the province is perforated by them. The habits of the larvæ and perfect insect are similar, both being equally fierce, and exclusively carnivorous.

Proceeding next to the numerous and important family of the *Carabidæ* we shall find that we have but one species at all worthy of comparison with the twelve fine species of *Carabus* which are found in the mother country. The splendid genus *Calosoma* is, so far as I know, totally wanting. The same may be said of the beautiful *Callistus* and *Drypta*, and the curious *Brachinus*. Indeed, I may take this opportunity of remarking that although the New Zealand insects in many cases closely resemble English ones, yet this resemblance is almost always to small and dull coloured species, and hardly ever to the fine or conspicuous ones. The large beetle to which I have alluded above is *Feronia australasiæ?* It is about an inch long, of a bronze colour, and very common in the neighbourhood of Christchurch under wood and stones. Seven other species of *Feronia* occur in New Zealand, but, owing to the loss of my collection, I cannot say how many of them I have taken in Canterbury. The Islands, and probably this province, possess at least five species of *Anchomenus* very similar to their English relatives. The genus *Amara*, so numerous in England, and which comprises what children call "sunshiny beetles," does not occur in the "Zoology of the 'Erebus' and 'Terror,'" but having taken a considerable number of specimens quite lately I feel certain that either it or a closely allied genus is common in Canterbury. The remarkable genus *Broscus* is well represented in New Zealand, but most of its specimens appear to have come from Otago. I may remark that none of them equal in size the single British species *Broscus cephalotes*, which is usually found under stones on the sea coast. Of the extensive genus *Harpalus*, which numbers twenty-eight species in England, I am only sure of having taken a single one. *H. novæ-zealandiæ.* It is abundant at certain seasons of the year upon the sand-hills near Christchurch. I am not able to afford any more information with regard to this important family, but I may note that many of our species have been recently described by Count de Castelnau in the Proceedings of the Royal Society of Victoria, but I have unluckily mislaid his paper. Farmers and gardeners will do well to observe that all members of the families *Cicindelidæ* and *Caribidæ*, being carnivorous, are extremely beneficial to them, and should on no account be destroyed.

We have now arrived at the interesting family of the *Dytiscidæ*, or water-beetles, with which New Zealand is but poorly provided so far as the number of species is concerned, though the individuals comprising them are often very

numerous. I once procured a single specimen about an inch long, and I imagine from the description that it must have been the *Cybister hookeri* of White, the entomologist, who described the species collected by the naturalists of the "Erebus" and "Terror." This beetle was about equal in size to the English *Dytiscus*, of which there are five species. Two species of *Colymbetes* are described by White. One of them, *C. rufimanus*, is very common in Christchurch, where it thrives in artesian water. All the *Dytiscidæ* are voracious creatures, and in Europe they have sometimes been credited with doing damage to young fish. That *D. marginalis* can destroy a fish of tolerable size I have myself often proved, though I do not imagine the mischief they do in this way to be appreciable. We have, apparently, no representative of the huge *Hydrous piceus*, one of the largest beetles in Britain, and about two inches in length. The small family of the *Gyrinidæ*, or "whirlwhigs," which may be often seen moving in circles upon the ponds and ditches of Europe, seems also to be wanting. Owing to the peculiar habits of water-beetles they are but seldom seen, save by the collector, and we may therefore expect that our list will be largely increased.

The division *Brachelytra*, or the family *Staphylinidæ*, comes next in order. White describes but three species, and 700 occur in Britain, so it is obvious that many remain to be noticed here. These insects, on account of their long slender form and short elytra, are seldom supposed to be beetles by the uninitiated, though on a close inspection their affinities are obvious. Our largest species is *Staphylinus oculatus*, which, however, is not a quarter the size of *Ocypus olens*, the well known "devil's coach-horse" of England. It is abundant under the carcases of sheep and oxen, and though indigenous, it is probably one of those insects which have increased since the colonization of these islands. Only two other species are described by White, and we may safely assume that all the others remaining are small and insignificant. All the individuals belonging to this family render themselves useful to man by removing putrefying matter and preying upon noxious insects.

Following Rye's classification we next arrive at the section *Necrophaga*, the members of which feed upon dead animal substances, and which comprises the burying-beetles of Europe. We need not expect to find many representatives of this family here. I only know of one small species belonging to *Saprinus*, a genus which numbers 105 species in Europe. This beetle is abundant in sheeps' heads and other carrion. I have not been able to compare it with the species of Australia, but, from having found it in the carcases of native birds, I think it is most likely indigenous. This species, also, has probably increased largely since the importation of cattle.

Leaving out several families which I imagine to be totally wanting, we come to the *Melolonthidæ*, a family too well known to us by the ravages it

commits on our lawns and pastures. The best known example of this family is the common cockchafer of the British Isles, and our species, though much smaller, almost rivals its destructive habits. Three specimens, viz., *Odontria striata*, *O. cinnamonea*, and a third and smaller kind as yet undescribed, are abundant in this province. I have never heard of the larger *Xylonychus* being taken in Canterbury, though it is common at Wellington. To this family belongs also *Pyronota festiva*, to which I have previously alluded.

Next to the *Melolonthidæ* the coprophagous beetles, comprising the families *Geotrupidæ*, *Copridæ*, and *Aphodiadæ*, etc., are usually placed. In no section is the paucity of the New Zealand *Coleoptera* more conspicuous than in this, which is celebrated for the quaint and grotesque forms of the members composing it, and for the reverence paid to one of its species by the ancient Egyptians. By way of illustrating this contrast, let us take a plain frequented by cattle in the south of Europe, on the banks of the Tiber for instance, and compare it with a similar locality in New Zealand. There we shall find every piece of dung swarming with various species of *Aphodius*, *Onthophagus*, and *Oniticellus*. Beneath, the ground is perforated with the burrows of the huge horned *Copris* and *Geotrupes*, and around the mystic *Ateuchi* are busily engaged in their sisyphean tasks, whilst the air resounds with the hum of the more active *Gymnopleuri*, and numerous *Carabidæ* are present to feed upon the other species. Here, on the contrary, so far as insects are concerned, all is silent and motionless, and the coleopterist who was totally ignorant of the history of New Zealand might infer a great portion of it from the absence of these beetles alone. Specimens of *Onthophagus granulatus* have been taken by Mr. Fereday in the province of Nelson, but as Mr. Bates considers them to be identical with the Australian species, there can be no doubt that they have been imported with cattle. I have taken an *Aphodius* near to Christchurch, and am disposed to think that this small species may be indigenous. A relative of the last-named beetle, *Oxyomus exsculptus*, is described by White, but the locality is not mentioned.

But although nature, not having provided New Zealand with large quadrupeds, was under no obligation to provide scavengers for the removal of their excrement, yet, as if anxious to supply the deficiency, she has furnished us with some conspicuous members of the *Dynastidæ*, a family most closely allied to them. Having no collection to refer to, I cannot say whether the two species figured by White occur in this province, but, at least three species of the family are abundant on the sand-hills. At some seasons of the year they must be exceedingly common, for the ground is often covered with their dead bodies, but I have only met with one specimen alive during an experience of fifteen years. Doubtless some residents on the sand-hills can throw light on the habits of this insect, which are apparently very peculiar.

The larvæ are often found under cow-dung and logs of wood, and a short time since Mr. M. Walker forwarded to Dr. Haast a fine specimen of the perfect insect, which he had obtained by digging below high water-mark. The nearest ally to these beetles in my European collection is *Pentodon punctatus*, common in the vicinity of Rome, but with apparently different habits.

Amongst the *Lucanidæ* we find the gigantic stag-beetle represented by the pigmy *Lissotes reticulatus*, a strongly made, flat insect, about six lines in length, and common in this province under bark and in decayed wood. A *Dendroblax*, and two species of *Dorcus*, which seem to be remarkable, also occur in New Zealand, but I have not met with them in Canterbury.

Glancing next at the *Sternoxi*, comprising the families *Buprestidæ*, *Elateridæ*, etc., amongst which are found some of the most gorgeous beetles of the tropics, we at length meet with a section of which the New Zealand specimens are decidedly superior to the British, though not, perhaps, to those of southern Europe. The English species are all small and inconspicuous, whilst several kinds of *Ochosternus*, commonly found here, are large and handsome insects, though they cannot boast of brilliant colouring. Being without a collection for reference, I cannot venture to enumerate even those kinds which I have myself taken, but seeing that White describes twelve species of *Elateridæ* alone, and the number has doubtless been considerably increased since his time, we may safely assume that New Zealand is well represented. The larvæ of the larger species of this division live in dead wood, upon which the perfect insects are generally found.

I regret that I can furnish little or no information respecting the extensive division of the *Malacodermi*, the best known examples of which are probably the "soldiers" and "sailors" of Britain, and to which also the common glow-worm belongs. The only species contained in my slender collection is *Nacerdes lineata*, Fab., which I have taken in great numbers at Little River under the bark of decayed trees. I have also a *Ptinus*, taken in Riccarton Wood by Mr. Fereday, and I find that an *Atopida*, two species of *Opilus*, an *Anobius*, and three other species of *Ptinus*, occur in New Zealand.

The section *Heteromera*, of which the meal-worm, so well known to bird fanciers, may be taken as a familiar type, is next to be noticed. Our species are mostly small in comparison with those of Europe, but the individuals composing them are often exceedingly numerous. These are light-shunning insects found under bark and stones, and not unfrequently amongst sacks and clothes which have been long undisturbed. One species is often met with in Christchurch, but I have taken a much larger under bark in Talbot Forest, and I once found a small species so abundant on the sea coast beyond Amuri as to be a perfect nuisance. Many species of this section may be easily mistaken for *Carabidæ*. *Adelium harpaloides*, a small species, affords a good

example of this apparent resemblance between the two orders. I possess a few specimens of *Prioscelida tenebrionides*, White, but have never taken it in Canterbury. Two species of *Cilibe* and two of *Opatrum* have also been described from New Zealand. I have found a *Mordella* (probably *antarctica*) at Little River, and have a specimen of *Mordella* 10-*guttata*, but do not know in what part of these islands it was taken. The singular family *Meloidæ*, or oil-beetles, appears to be unrepresented in this colony. Two species of *Selenopalpus* described by White, and belonging to the same family as the beautiful *Œdemera cærulea* of Britain, would seem to be worthy of notice, but I am only acquainted with one of them.

We now enter the *Rhynchophora*, or weevils, a section well represented in New Zealand, where some species are to be found finer than any of the British. Although I am not aware of any member of the remarkable family *Brentidæ* having been taken in Canterbury I cannot pass it over in silence, as it is the most characteristic one amongst the *Coleoptera* of New Zealand. These insects are easily recognized by their enormous snouts, and one species at least (*Lasiorhynchus barbicornis*) is common at Wellington, and occurs also, I believe, in Nelson. I am not well acquainted with the exotic species, but a few which I possess from Mexico are much inferior to ours. Amongst the *Curculionidæ* the largest species I know of has been taken by Mr. Fereday on black-birch trees. It belongs to the genus *Rhyncodes*, and another large species (*Rhyncodes saundersii*) has been found by the same gentleman on "spaniards" (*Aciphylla*) at the Rakaia. I am not able to enter into details respecting the numerous smaller species of this family, but the curious genus *Scolopterus* deserves a passing notice. *S. penicillatus* has been taken by Dr. Powell, I believe, at Governor Bay, and I have found the same insect at Amuri.

We now enter upon an important section, the members of which may be easily recognized even by those who have paid no attention to entomology. The *Longicornes* are, for the most part, wood-feeders, and the coleopterist would naturally expect to find them abundant in so densely timbered a country as some parts of New Zealand. Nor will he, on the whole, be disappointed, although our species can scarcely be said to equal those of Britain. To this group belongs the largest beetle found in these islands, *Prionoplus reticularis*, a species which is abundant throughout their whole extent. I hardly need mention that the larvæ of this beetle used to form an important article of diet amongst the Maoris, but it is interesting to note that a similar grub was considered a dainty by the ancient Romans, and that one of their patrician families received its name therefrom. Linnæus, indeed, applied the word "cossus" to the larva of the goat-moth, but it is now generally admitted that the larva in question must have been coleopterous. These insects undoubtedly live in the wood for several years before assuming

their perfect shape. The larvæ of the stag-beetle are said to live in the wood for four years, and many other wood-boring beetles are supposed to exist in it for a still longer period. Though I have no positive proof I feel certain, from observations I have made, that *Prionoplus* passes at least four years in the larva state. Upon leaving the province several years ago I put aside a log which I knew to contain larvæ of *Prionoplus*, and requested a friend to watch it during my absence. Upon returning, after an interval of three years and a half, I split open the log and found larvæ still there. Perfect insects might have visited the log whilst I was away, but, under the circumstances, it is hardly possible that they should have done so. The nearest ally to *Prionoplus* amongst the British beetles is *Prionus coirarius*, an insect which is by no means common.

Next to *Prionoplus* the best known of our *Longicornes* is *Coptomma variegatum*, a handsome insect, about 10 lines in length, which I have frequently taken on posts and rails near Christchurch, though the forest is, of course, its proper habitation. I have found *Obrium fabricianum*, the smallest of the family, abundant upon flowers at Hoon Hay. A Longicorn which I have taken under titoki bark on the Peninsula is of a new species and genus also. Besides these kinds the following have been kindly given to me by Mr. Bates and Mr. Fereday, but all, I imagine, were taken in the North Island. *Hexathrica pulverulenta*, Westw., *Tetrorea cilipes*, White, *Navomorpha lineata*, Fab., *Xylotetes griseus*, F., *Œmona villosa*, F., and *Ambeodontus bituberculatus*, Reatenbacher. Many other *Longicornes* have been described and figured by White in the work to which I have so often alluded, but they all seem to have been taken in the North Island, and I am acquainted with none of them.

According to the classification which I have followed, the *Eupoda* next claim our attention. This section comprises some of the most beautiful genera of Britain (*Donacia*, *Chrysomela*, etc.), but I am almost totally ignorant of its representatives here. White describes two species of *Chrysomelidæ*, and I have taken at least one allied to *Crepidodera*. The *Pseudotrimera* conclude the order, and amongst them the *Coccinellidæ*, or lady-birds, are well known and widely distributed. Of the three or four species which I have taken in this province, none are equal in size to the common *7-punctata*, of England, and their colours and markings are generally inferior. I possess, indeed, three very beautiful species, (*Chilomenes hamata*, Muls., *C. maculata*, Fab., and *Epilachna reticulata*), which I procured from a London dealer, but I feel certain that they must have been taken in the North Island.

In conclusion, I wish to offer a few remarks respecting the ease with which insects of the order *Coleoptera* may be collected and preserved. It is partly to the ignorance of this, and not entirely to apathy, idleness, or contempt of

science, that I attribute the wretched state of colonial museums so far as indigenous beetles are concerned. Even at Melbourne the entomological collection is beneath criticism. To preserve *Coleoptera* for an indefinite period it is only necessary to put them into a phial containing any kind of spirits. *Orthoptera* and *Hemiptera* may be kept in the same manner, and even *Hymenoptera*, *Neuroptera*, and *Diptera* will suffer but little from such treatment. A still better method for beetles, and one which, undoubtedly, preserves their colours more perfectly, is to put them into sawdust moistened with spirits, care being taken not to make the mixture too wet. It now only remains for me to express a hope, that, if not anticipated by an abler hand, I may be in a position, on some future occasion, to lay before you fuller and more exact information respecting this interesting order of insects.

ART. XXXV.—*On the Skeleton of an Aboriginal Inhabitant of the Chatham Islands.* By F. J. KNOX, L.R.C.S.E.

[*Read before the Wellington Philosophical Society, 30th October,* 1872.]

THE skeleton forming the subject of the following observations was that of a female, in all probability of about middle age, and was obtained in a cave on the Chatham Islands by Mr. H. Travers. The state of the bones indicates a very lengthened exposure to the action of solvents leading to the disappearance of the gelatine and chondrine, which form the original elementary basis of the skeleton. A few of the bones were wanting, but these are of slight comparative importance, so that the skeleton as now deposited in the Museum will form an object of scientific inquiry inasmuch as it may be depended upon, not only in its history but in its composition.

In contemplating the trunk and its appendages the almost universal lateral curvature of the spine towards the right shoulder, common amongst the most highly civilized European classes, is observable in this instance. This curvature is not considered pathological but perfectly natural, and arising from a *congenital* increase in the development of the entire right side of the body. An excurvation of the spine observed in some instances amongst the Maoris, and attributed by some writers on the Maori race to the awkward form of the entrance to their dwellings, is in fact the result of disease, inherited or produced, and is much more common in the large cities of England than in New Zealand. It is in fact a disease attacking in general the sixth or seventh dorsal vertebræ, leading to suppuration in the bodies of these vertebræ, loss of substance, and a consequent angular curvature of the column, terminating in

the well known hunchback or in death. The bodies of the fourth and fifth lumbar vertebræ in this skeleton exhibit the effects of excessive and long continued pressure from carrying heavy weights, such as firewood. The ribs and thorax are normal, but slightly twisted in consequence of the lateral curvature of the spine above alluded to. The sternum, strictly normal, consisting of manubrium, body and ensiform cartilage. The scapulæ and clavicles, though well formed, are unusually small. The clavicles at their sternal articulation exhibit the effect of chronic enlargement during life.

The pelvis is well formed, and appears to me not to indicate inferiority such as is said to be present in the dark Negro races. I refer to the table annexed for the measurements taken, as showing no marked deviation from the average dimensions of the pelvis in fairer races. The excessive development of the bones of the face, and more especially the upper and lower jaw, so much dwelt upon by closet naturalists and compilers as indicating a deviation from the Caucasian type towards that of the monkey, is, I think, a mere fancy—a matter of taste in short. I have repeatedly observed the jaws, more especially the lower, of ample dimensions in many of the fair races, and, if I mistake not, the robust development of the lower jaw, not only at the symphysis but at the angle, indicates firmness and obstinacy of character, whether in male or female.

The head when placed on a horizontal smooth surface rests on the mastoid processes of the temporal bone and angle of the lower jaw. The skull (without the lower jaw) when placed on a horizontal smooth surface, rests on the mastoid processes of the temporal bone and third molar tooth. When on the vertex it rests on the position of the anterior fontanella, which in this instance is not only completely obliterated, but forms a well marked elevation deserving the attention of the phrenologist. The external surface of the cranium presents a slight tendency to form crests on the parietal bones. The sutures are all perfectly normal. The condyles of the lower jaw (transverse measure 10½ lines), show very little of any hinge-like or lateral action of the jaws. The teeth originally small, much worn down, particularly the canines, so as scarcely to be distinguished from the incisors.

The locomotive organs, both thoracic and pelvic, appear to me finely formed. The arms, including the humerus, radius and ulna, and hand (or arm, forearm, and hand) measure in length 2 ft. 2 in. 9 lines. The legs, including the thigh, leg, and foot, measure 2 ft. 7 in. 9 lines. It will be observed from an inspection of the articulated skeleton that these present a degree of beauty not surpassed by any existing people, more especially the foot which exhibits a fine arch and short calcaneum—the female foot *par excellence!*

Measurements. — Head (including lower jaw) placed on a horizontal

smooth surface, greatest height 6 in. 6 lines; antero-posterior diameter, 6 in. $10\frac{1}{2}$ lines; transverse diameter, 5 in. 6 lines; breadth at zygomatic arches, 5 in. 4 lines; breadth of upper jaw over third molar tooth, 2 in. 7 lines; length of base of skull from symphysis to anterior margin of occipital foramen, 3 in. $7\frac{1}{2}$ lines; length from symphysis to anterior margin of occipital crest, 6 in. 9 lines; length from symphysis to occipito-parietal suture, 8 in.

Lower jaw.—Depth at symphysis, 1 in. 3 lines; depth at coronoid process, 2 in. 6 lines; breadth between angles of jaw, 3 in. $4\frac{1}{2}$ lines; breadth between condyles, 3 in.; breadth of space over the last molar tooth, 2 in. $1\frac{1}{2}$ lines.

Length of skeleton articulated.—Head, greatest height, 6 in. 6 lines; body, including the entire spine, 2 ft. 5 in. 6 lines. Total length of skeleton, 5 ft. 7 in. 9 lines.

In the living body allowance must be made for the curvatures of the spine, the elongation of the sacrum beyond the hip joint, and the position of the foot, so that the height would probably be about five feet from the crown of the head to the sole of the foot.

Pelvis.—Greatest depth, 7 in.; greatest external breadth, 9 in. 6 lines; depth of symphysis, 1 in. 6 lines; brim, antero-posterior diameter, 5 in., transverse diameter, 5 in.

Thoracic locomotive organs.—Humerus, 11 in. 3 lines; radius, 8 in. 6 lines; carpus, 1 in. 3 lines; metacarpus of third finger, 2 in. 6 lines; phalanges of third finger, 3 in. 3 lines. Total, 2 ft. 2 in. 9 lines.

Pelvic locomotive organs.—Femur, 1 ft. 4 in.; tibia, 1 ft. 0in. 9 lines; height of foot, 3 in. Total, 2 ft. 7 in. 2 lines. Length of foot, 8 in. 3 lines.

Weights.—Skull, 1 lb. 8 oz.; lower jaw, 3 oz. Total weight of head, 1 lb. 11 oz.

Body, including cervical, dorsal and lumbar vertebræ, together with the ribs and sternum, 1 lb. 8 oz.; pelvis, including sacrum and coccyx, 12 oz.; scapulæ, 3 oz.; clavicles, 410 grs.; thoracic locomotive organs (arms), 12 oz.; pelvic locomotive organs (legs), 2 lbs. Total weight, 6 lbs. 14 oz. 410 grs.

The usual weight of an adult human skeleton varies from 10 lbs. to 12 lbs. 8 oz., but, as I have already alluded to the greatly altered condition of the bones in the case of this skeleton, little importance can be attached to the weight as compared with others in which the bones still retain the original osseous tissue.

ART. XXXVI.—*Observations on* Naultinus pacificus, *Gray.*

By F. J. KNOX, L.R.C.S.E.

[*Read before the Wellington Philosophical Society, 29th January,* 1872.]

ON the 20th October, 1869, a neighbour brought me a lizard incarcerated in a gin-bottle. The prisoner was extremely restless, and my friend stated as a caution that when captured it was very lively, offering a spirited resistance. After a week's imprisonment, on 28th October, I determined to improve the condition of the prisoner, having previously prepared a more suitable habitation for him, but having to break the bottle, in the struggle the tail was detached from the body precisely at the apparent junction with the sacrum, at what is generally called the "setting on of the tail." On being secured in his new residence (still, of course, a prisoner) he did not appear conscious of the loss of his caudal extremity, but surveyed every corner for the means of escape. As bearing on the feeding habits of this lizard I may state that small portions of flesh were put beside him, and an active blue-bottle fly having fancied the raw meat was suddenly struck by the lizard with the rapidity of lightning, and with a force which crippled it. During his efforts to regain his liberty he frequently, I could observe, licked with his tongue the entire surface of the face, including the eyes. Three days after the accident the lizard appeared dull, but when disturbed still only anxious to obtain his freedom. The stump where the tail was detached was swollen and evidently painful. He refused all food, but was still active till the seventh day, and on the eighth died.

On dissection he proved to be a male, the generative organs not active.

SKELETON.

Vertebræ—body	... ...	26
sacral	... .	8
caudal	... ...	29
	Total	63
Ribs	... ...	26

Weight, recent, 156 grs. ; weight of skeleton, 18 grs. ; and of soft parts 138 grs.

It has been stated that when the tail of a lizard has been amputated the detached portion will be reproduced in its entirety. Scientific men will naturally require minute details of such an experiment, with reliable authority. We have shown in the preceding article that the tail of the *Naultinus pacificus* was separated (not amputated), and it will be seen that the place where the separation took place presented no appearance of laceration or cutting, with the exception of the spinal cord. The greatest care and attention was bestowed upon the lizard, but unmistakeable symptoms of the injury exhibited themselves, and death rapidly followed.

I have examined a specimen of a lizard in the Colonial Museum presenting the phenomena of two tails nearly of equal size, and it has appeared to me that the possession of a supernumerary tail in this case may be attributed to the class of monstrosities. We know that lizards are developed within the isolated egg, and it is well understood that monstrosities are comparatively common in oviparous animals.

A question of much interest thus remains still to be solved, viz., Is the tail reproduced in its entirety, when the whole or even a portion of it is forcibly or accidentally removed? In the dead specimen described by me in a previous article* I found the continuation of the medulla spinalis left the canal without the least disturbance, and when thus drawn out as it were, it presented a series of swellings (ganglia) exactly corresponding to the number of the vertebræ. My theory, therefore, was that any regeneration of the tail would be mere integumentary reproduction.

I have shown in the present paper that, when violently detached in the living animal, the medulla spinalis does not leave the canal, but is torn across, the detached portion remaining in the tail. My specimen forming the subject of the present memoir died on the eighth day after the accident, and the eighteenth day after the capture and confinement, but whether from the want of nourishment or the loss of his tail it is impossible to say.

Art. XXXVII.—*Note on* Ctenolabrus knoxi. By F. J. Knox, L.R.C.S.E.

[*Read before the Wellington Philosophical Society, 14th August,* 1872.]

A fish captured in Cook Strait, close to Porirua Harbour, and amongst others such as the moki, snapper, etc., was pointed out to me by the salesman as a rare fish, and will be described under the above name by Capt. Hutton (see p. 265).

General colouration dark brown, passing to dull white on abdominal surface; head and gill-covers of a dull greenish hue; pectoral fins colour of dorsal aspect; pelvic and anal fins colour of abdominal aspect, with a reddish tinge, indicating spawning season.

Intestines 6 feet in length, of a delicate texture, filled with a green pasty substance, not oily to the touch; liver greenish brown colour, friable, composed of three irregularly shaped lobes; gall-bladder not observed; spleen one inch in length by half an inch, texture firm, of a dark red colour; generative organs (female) just after spawning, from the large dimensions of the oviducts the spawn or ova must no doubt be very numerous. Food, *Diatomaceæ*. Weight, recent, 3 lbs. 7 oz. Total length, 19½ inches.

* *Trans.* N.Z. Inst. Vol. II., p. 20.

III.—BOTANY.

Art. XXXVIII.—*Preliminary Notes on Mr. H. H. Travers' Recent Collections of Plants from the Chatham Islands.*

By Baron Ferd. von. Mueller, C.M.G., M.D., F.R.S., Hon. Mem. N.Z.I.

[*Read before the Wellington Philosophical Society, 20th July,* 1872.]

During the last spring and summer the Chatham Islands were revisited by Mr. H. H. Travers, with the view of exploring still further these islands for zoological and phytological purposes. The plants collected have also on this occasion been submitted to me for examination. But as the careful elaboration of all the species—many of variable form—will require some time, I have thought it advisable to offer meanwhile a few preliminary notes on these new collections. The latter comprise the *Dicotyledoneæ*, *Monocotyledoneæ*, and Ferns brought this time by Mr. Travers, and they increase the 67 genera and 87 species obtained in 1864 to 123 genera and 183 species, 56 genera and 96 species being added. Accordingly the *Dicotyledoneæ*, known to belong to these isles, comprise now 72 genera and 94 species; the *Monocotyledoneæ* 34 genera and 52 species; and the *Filices* and closely allied plants, 17 genera and 37 species. A few of the cotyledonous plants are evidently introduced; yet, after deducting these, there still remain a comparatively large number of indigenous species for so small an area, particularly if it is considered that no high mountains exist in this group as in Lord Howe Island.

The plants now brought by Mr. Travers still further prove the vegetation of the Chatham Islands to be almost identical with that of New Zealand; for even the apparently few endemic plants are almost all closely allied to New Zealand species. The total absence of *Myrtaceæ and Pittosporeæ* seems remarkable. The *Cordylines,* so conspicuous in the vegetation of New Zealand, are also absent; and many common plants of the latter and also of other countries, for instance *Adiantum æthiopicum,* have not yet been found. A few additions to the phanerogamic flora may still be expected among insignificant water-weeds, such as *Lemna,* or among the oceanic *Monocotyledoneæ*, such as *Zostera, Cymodocea,* and *Halophila,* otherwise Mr. Travers' search seems to have been almost exhaustive. The Mosses, Lichenastra, Lichens, Fungi, and Algæ, have been more extensively collected only during Mr. Travers' second

stay on the islands; none of these have I yet seen, as they were not arranged for distribution. But the Algæ of Mr. Travers' first collection have been elaborated with masterly knowledge by Professor J. G. Agardh of Lund (in "Ofirsigt af Kongl. Vetenskaps Akademiens Förhandlingar," Stockholm, 1870), and from manuscript notes of Professor Agardh a list of these Algæ appeared also in the third volume of the *Transactions* of the New Zealand Institute, p.p. 213–215. The cotyledonous plants and ferns, now kindly placed at my disposal for examination, as supplementary to those enumerated in my "Sketch of the Vegetation of the Chatham Islands," comprise the following genera new to the group:—Ranunculus, Cardamine, Nasturtium, Lepidium, Viola, Drosera, Stellaria, Dodonæa, Discaria, Acæna, Callitriche, Tillæa, Haloragis, Myriophyllum, Daucus, Crantzia, Hydrocotyle, Oreomyrrhis, Apium, Brachycome, Craspedia, Erechtites, Helichrysum, Gnaphalium, Hypochœris, Wahlenbergia, Myosotis, Dichondra, Parietaria, Rumex, Atriplex, Rhagodia, Chenopodium, Salicornia, Triglochin, Ruppia, Potamogeton, Acianthus, Corybas, Thelymitra, Microtis, Schœnodum, Scirpus, Cladium, Chætospora, Isolepis, Uncinia, Danthonia, Hierochloa, Trisetum, Dichelachne, Poa, Tmesipteris, Schizæa, Ophioglossum, Lindsæa.

All these genera are represented also in the vegetation of the New Zealand islands. The species and their relations, geographically and phytologically, will become the subject of a special treatise.

The following list of Mosses has been named by Dr. E. Hampe, of Blankenburg:—

Sphagnum molliculum, *Wilson.*
Funaria connivens, *Hampe.*
Dissodon purpurascens (Splachnum purpurascens, *J. Hook. & Wils.*)
Dissodon cuspidatus (Splachnum cuspidatum, *J. Hook. & Wils.*)
Dicranum trichopyllum, n.s., *Hampe.*
Campylopus introflexus, *Bridel.*
Rhizogonium bifarium, *Schimper.*
Hypnum aviculare, *Bridel.*
Hypnum spininervium, *Hook.*
Hypnum ramulosum, *Mitten.*
Cyathophorum bulbosum, *Bridel.*
Catharomnion ciliatum, *J. Hk. & Wils.*
Racopilum australe, *C. Mueller.*

ART. XXXIX.—*On the Origin in New Zealand of* Polygonum aviculare, *L.*

By W. T. L. TRAVERS, F.L.S.

[*Read before the Wellington Philosophical Society, 23rd October, 1872.*]

IN the fourth volume of the *Transactions* of the New Zealand Institute, at p. 238, will be found a paper on this subject by Mr. Kirk, written, as it appears, in consequence of some observations of mine at p. 336 of the previous

volume, in which I assumed both the typical form of *Polygonum aviculare* and the variety *dryandri* to be of exotic origin. Notwithstanding Mr. Kirk's arguments I still disagree with the conclusions he has arrived at, and chiefly for the following reasons.

On looking into the history of botanical research in New Zealand we find that these plants are not mentioned by any collector before Raoul, who obtained the typical form at Akaroa and the Bay of Islands about 1840, whilst Lyall obtained the variety at Port Cooper some eight or ten years later. Now it would be somewhat singular that, if these plants really belonged to the indigenous flora, they should have been overlooked by Banks and Solander in 1769, by the Forsters and Dr. Sparrman in 1772, by Alexander in 1777, and by Menzies in 1791. I admit, however, that Alexander, whose collections were very limited, and Menzies, who directed himself almost exclusively to the *Cryptogamia*, might have overlooked these plants, though the fact would still remain a singular one. But with Banks and Solander and the Forsters and Dr. Sparrman the omission would be strange indeed, for each of these botanists enjoyed abundant opportunities of collecting in localities in which the typical form at all events could scarcely have failed to be found if it then existed in the country. It is still more remarkable too that neither plant is mentioned by D'Urville, who collected in 1822, by Frazer in 1825, by Allan Cunningham in 1826, nor by Lesson in 1827; but whilst their silence may be accounted for in a manner which will be mentioned in the sequel, the same reasons are in no degree applicable to the case of the earlier botanists.

It appears to me that Mr. Kirk has quite overlooked the great length of time which has elapsed since various European seeds, of classes likely to include, at all events, as accidental company those of *Polygonum aviculare*, have been introduced into New Zealand. In the first place there was, between 1793 and 1840, a constant intercourse on all parts of the east coast of the two main islands between the crews of whale and other ships from the colonies of New South Wales and Van Diemen's Land and the natives, during which time the seeds of a large variety of European herbaceous plants were introduced. As a notable instance we know that the seed of the English dock was sold to natives in various parts of the islands as the seed of the tobacco plant.

But outside of this, as possibly accounting for the presence of the plant in question, I call Mr. Kirk's attention specially to the fact that both in 1810 and in 1814 large quantities of European seeds were introduced into the Bay of Islands, and into various parts of the North Island lying between that district and Poverty Bay, by the missionary band of which the Rev. Mr. Marsden was the head. In the latter year particularly the brig "Active,"

which brought down Mr. Marsden and his companions to form the permanent missionary establishment, also brought down horses, cattle, sheep, pigs, goats, cats, dogs, and poultry of several species, in numbers sufficient to give the vessel the appearance of an ark, besides a great variety of seeds, especially wheat, barley, oats, Indian corn, and garden and grass seeds of various kinds, whilst considerable quantities of hay and other fodder, for the use of the animals during the voyage, also formed part of the general cargo. On 16th December, 1814, the vessel passed the Three Kings, and anchored on the coast some days afterwards, and between that time and the latter end of February, 1815, the voyagers landed in various places on their way down, distributing seeds, etc., and explaining their uses to the natives, who accepted them eagerly and expressed a great willingness to cultivate them. Mr. Kirk will find very valuable information in reference to this voyage and its incidents in "Nicholas' Evidence before the House of Lords Committee on 3rd April, 1837," p. 4. Now it is well known that the pigs and poultry then introduced increased with enormous rapidity, the former indeed to such an extent that in 1819 and 1820 they formed the principle articles of barter between the natives and the crews of the whale and other ships visiting the coast, in exchange for arms and ammunition, the natives even then hunting and catching them with dogs.

From the mission stations as centres down the East Coast as far as Poverty Bay, the seeds of numbers of the European plants, and the progeny of many of the animals also, were rapidly distributed. Major Cruise, in his account of the visit of the "Dromedary" in 1820, particularly mentions that nearly every war canoe carried a cock, a bird to which the natives took a great liking, in consequence of his crow and his bold bearing. I could multiply evidence to show the possibility of the introduction and rapid spread of the plant in question in the northern habitat mentioned by Mr. Kirk, at least twenty-six years before the colonization of Auckland; but I think the above facts, added to the silence of the earlier botanists, will satisfy him that something more is required than he has advanced in his paper, in order to prove that they are natives of the soil. But he will say that these facts do not dispose of the case of Banks Peninsula. Well, in regard to that locality, Mr. Kirk is probably not aware that besides the constant visits, before alluded to, of numbers of whale and other ships from Hobart Town and Sydney to the harbours of Akaroa and Port Cooper, large tracts of the pastoral country in the vicinity of both harbours were occupied by European settlers, with cattle and horses, so long ago as 1832. These animals were chiefly brought from Tasmania by the Greenwoods, and the hay and fodder necessary for their use during the voyages were almost certain to contain seeds of the plants in question, even if they did not occur amongst those which had been introduced

by the whalers, or amongst those of the various plants which were brought down by the Greenwoods and others mentioned.

With regard to the silence of D'Urville, Fraser, Allan Cunningham, and Lesson, it must be remembered that all these observers saw the extensive cultivations of the missionaries at the Bay of Islands and elsewhere, and if they did notice *Polygonum aviculare* at all, they would probably look upon it as having been introduced amongst the other European seeds which they saw flourishing there. In this connection Mr. Kirk will probably call to mind the interesting description given by Darwin of the appearance of the mission station at Waimate, in 1836, and no doubt any English botanist collecting at that time in that district would at once have treated our plants as exotic.

It must be remembered, moreover, that when Banks and Solander, and the Forsters, and Dr. Sparrman visited New Zealand, the cultivations of the natives were greatly more extensive than they are at present; and it is extremely improbable that neither in the numerous large tracts of cultivated land nor in the vicinity of the many extensive pas which they visited, nor along the many tracks which the natives then travelled, should specimens of a plant possessing the habits of *Polygonum aviculare* have been found, if it then existed at all as part of the indigenous flora of the islands.

No doubt many indigenous plants have increased with extraordinary rapidity of late years. I may instance for example the *Chrysobactron hookeri*, which has spread and is still spreading over thousands of acres of moist ground, on the higher part of the South Island pastoral country, owing to the removal by fire of a vegetation which does not renew itself after fire,—such as the sub-alpine species of *Dracophyllum*, *Discaria*, and *Veronica*—which in mingled growth usually cover the terraces and mountain sides in such valleys as those of the Acheron, the Clarence, the Upper Waiau, etc., in the Nelson province.

Even more remarkable is the extraordinary spread of *Triticum scabrum* (blue-grass of the settlers) which over hundreds of thousands of acres of the same class of country is gradually displacing the native grasses that first follow the destruction of the sub-alpine growth.

But none of these cases can be said to be strictly analogous to that of the *Polygonum*. In regard to each of the former certain checks have been removed, and the plant is profiting by such removal. In the latter the plant is always associated with the immediate occupation of land by man, making its habitation either in places which he has disturbed and then suffered to lie waste, or along the sides of the tracks which he makes over virgin country.

The spread of the *Polygonum* is more analogous to that of the plant commonly termed the Maori cabbage. In every part of the South Island in which we find any traces of native occupation or travel, even high amongst

the gorges of the Southern Alps, we also find the latter plant; but I doubt whether this evidence alone would satisfy Mr. Kirk that it is not a modified descendant of some form of *Brassica* originally introduced by Cook.

But in addition to the foregoing evidence I call Mr. Kirk's attention to the case of the Chatham Islands. Ever since 1836 these islands have been visited by whaling ships, hailing during the earlier years exclusively from Hobart Town. In the year 1854 several vessels from Melbourne and Sydney, freighted with horses and cattle, went down to those islands, making very profitable trade with the Maoris who then occupied them, the trade being chiefly in potatos, then in good demand at the several diggings. For one entire horse the Maoris paid £250, whilst they gave correspondingly good prices for the other animals. Now soon after this trade began a considerable number of common English weeds, and amongst them *Polygonum aviculare*, made their appearance on the islands. These facts are given on the authority of Mr. Hunt and others who have long resided there, and have had ample opportunities of observing them, and they are quite analogous to those which I have mentioned above as applying to New Zealand.

I do not think it necessary to follow Mr. Kirk in his criticisms upon the value of the Maori evidence in favour of the exotic origin of the plants in question, but I think I could satisfy him that such evidence is of more value when obtained from southern natives than if obtained from natives in the north.

I cannot, moreover, close these observations without mentioning what will probably interest and surprise Mr. Kirk, namely, that I have always considered *Azolla rubra* as a foreign plant. I remember perfectly noticing its first appearance in Nelson, and it was then looked upon as having been brought from Tasmania with many other introductions of a more unsatisfactory character.

NOTE.—22nd February, 1873. Since the foregoing paper was read I have seen Mr. Kirk's reply to my observations (see Art. XL.), but, in reference to Anderson's mention of a knot-grass, it appears to me that Mr. Kirk has overlooked the fact that *Polygonum decipiens* was collected by Banks and Solander, and would no doubt have been called a knot-grass by Anderson.—W. T. L. TRAVERS.

ART. XL.—*Further Notes on the Nativity of* Polygonum aviculare, *L., in New Zealand, in reply to Mr. Travers.* By T. KIRK, F.L.S.

[*Read before the Auckland Institute, 23rd December* 1872.]

IN the fourth volume of the *Transactions* I had occasion to point out the inaccurate and misleading character of the statement on which Mr. Travers based his opinion respecting the nativity of *Polygonum aviculare*, as expressed at page 336 of the third volume. I am now indebted to the courtesy of that gentleman for a copy of a paper (see Art. XXXIX.) read by him during the present session of the Wellington Philosophical Society, on which I am desirous of offering a few remarks.

Mr. Travers does not attempt any defence of the grounds upon which his theory was previously based, but still considers the plant to have been introduced, first, from the alleged absence of any reference to it by the earlier botanists, and secondly the possibility that seeds may have been brought amongst those of cultivated plants, or in other ways by the early missionaries, or by the whalers and trading vessels that visited the islands prior to the commencement of systematic settlement. The statements under the latter head occupy the chief portion of his paper, and may be dismissed with few words. Such a "possibility" has never been disputed, but is a very different matter from the real question at issue, and would have equal force if adduced to support the alleged introduction of other plants whose nativity has not yet been called in question.

To prevent misconception I quote the passages in Mr. Travers' paper respecting the absence of mention of this plant by the early botanists :—

"Now it would be somewhat singular that, if these plants (*Polygonum aviculare* and var. *dryandri*) really belonged to the indigenous flora, they should have been overlooked by Banks and Solander in 1769, by the Forsters and Dr. Sparrman in 1772, by Anderson in 1777, and by Menzies in 1791. I admit, however, that Anderson, whose collections were very limited, and Menzies, who devoted himself almost exclusively to the *Cryptogamia*, might have overlooked these plants, though the fact would still remain a singular one. * * * It is still more remarkable too that neither plant is mentioned by D'Urville, who collected in 1822, by Fraser in 1825, by Allan Cunningham in 1826, nor by Lesson in 1827," (see p. 311).

The value to be attached to the argument based on the above statement depends upon the completeness and extent of the collection made by each botanist, and especially on their having included those plants common to Europe (particularly to the British Islands) and New Zealand. It is therefore desirable briefly to consider the number of species recorded by each in connection with the localities visited.

Banks and Solander, 1769.—These botanists examined a large number of rich and interesting localities between the "Bay of Islands and Otago, including the shores of Cook Strait." The expedition spent five months in exploring the coast, and the number of flowering plants and ferns collected or recorded during its stay is larger than that of any other botanist named by Mr. Travers, yet it is under 380 species.

The Forsters and Dr. Sparrman, 1772.—Their collections were remarkably small, numbering only 160 species.

Anderson. 1777.—Dr. Hooker states that this collector obtained "very little indeed, and nothing of any importance."

Menzies, 1791, devoted himself to the collection of mosses and *Hepaticæ*.

D'Urville, 1822, and Lesson, 1827, collected in the Bay of Islands, the Thames River, Cook Strait, and other rich botanical localities, yet their joint collections numbered only 200 species, which were described with 60 or 70 of the Forsters' plants by Professor Richard.

Fraser, 1825.—Dr. Hooker writes: "Mr. Charles Fraser, the Superintendent of the Sydney Botanical Gardens, landed for one day in the Bay of Islands, and made a small collection of dried plants. He, however, procured more living ones."

Allan Cunningham, 1826.—After deducting the vast number of spurious species described by this energetic explorer the total number of plants *collected* by him will be found somewhat less than that of Banks and Solander.

Notwithstanding Mr. Travers' opinion on the singularity of no mention of the knot-grass having been made by Anderson and Menzies, I am sure that most observers will agree with me in considering that the extremely limited collection of the one, and the almost exclusive attention paid to Cryptogams by the other, afford excellent reasons for neither having made special mention of so common a plant. Neither could it be supposed that Fraser would have collected it during his single day's exploration at the Bay of Islands.

Leaving out of consideration, on account of their extremely fragmentary character, the small collection of 160 species made by the Forsters and Dr. Sparrman, by D'Urville and Lesson, of 200 species during two voyages, the very few plants collected by Anderson, and the mere names (so far as Mr. Travers' views are concerned) of Menzies and Fraser, the only collections of any extent are those of Banks and Solander, and of Cunningham. As the remarks I shall have to make apply with almost equal force to each I shall confine myself more particularly to that of Banks and Solander.

As already stated the recorded number of species of phænogamic plants and ferns observed by these botanists is between 370 and 380, collected during five months in "Poverty Bay, Tegadoo, Tolaga, Opuragi, the Thames River, Bay of Islands, Queen Charlotte Sound, and Admiralty Bay." Does

Mr. Travers wish it to be understood that the extreme number I have given (Dr. Hooker states "upwards of 360") comprises all the plants actually seen by Banks and Solander in these varied and distant localities? If so I am sure that no botanist possessing a detailed knowledge of the distribution of New Zealand plants will be found to agree with him. From personal knowledge of three of the localities visited by them I can state that a larger number of species might be collected in *each* during a single week than appears to have been recorded by them as obtained during the whole time spent on the coast of New Zealand, notwithstanding that some of the species which were common in 1772 are now comparatively rare. Making every allowance for the limited extent of their excursions into the interior, and guided by the preserved statements of the localities visited, and what we know of the nature of the habitats from the plants actually recorded as having been first observed by them, there can be no doubt that a minimum number of 600 species might have been collected by botanists in their position. Assuming, however, a much lower estimate, say 500 species, how very natural that so common and unattractive a plant as the knot-grass should have been one of those omitted.

In the comparatively small amount of attention which was paid to common and well known plants a century or even half a century ago by botanists in a similar position to Banks and Solander, and in the restricted facilities then to be obtained for preserving plants on board ship, may be found fully sufficient reason for no mention being made of so common a plant as the knot-grass, or for no specimen of it having been preserved.

And not to mention the omission of certain endemic plants, common in several of the localities visited by them, I might say amongst the commonest, this view of the case is confirmed by the fact that other plants common to the British Islands and New Zealand are omitted from their collections, although no botanist would for a moment imagine on that account that they were not observed. *Juncus maritimus* is abundant all round the coasts of New Zealand, it is especially plentiful at the Bay of Islands, Thames River, Mercury Bay, Bay of Plenty, Poverty Bay, and Queen Charlotte Sound—all localities visited by the first expedition, and at some of which a protracted stay was made—yet no mention is made of it, although it could not possibly have escaped observation. *Juncus bufonius* appears to have escaped record by all botanists down to the time of Sinclair and Colenso, and affords in many respects a close parallel to its frequent associate the knot-grass; it occurs throughout the islands in dry and moist places, is especially abundant by road sides, although rarely absent from swampy places; in neglected cultivations it sometimes exhibits great luxuriance, and ascends the Southern Alps to a considerable altitude. In the northern part of the colony, and probably

throughout, it resembles *Dichelachne crinita*, *D. sciurea*, and other unquestioned natives, in having increased largely during the last eight or ten years, and often exhibits a luxuriance surpassing anything to be seen in the British Islands, even in Ireland where its climatal advantages most nearly resemble those of this colony; yet its nativity is unquestioned, and there exists not the slightest ground for disputing it. A third species of this genus common to both countries was noticed by Banks and Solander, apparently on account of some slight differences having led them to consider it distinct. *Lemna minor* is another common European plant which often covers pools and quiet places on the margins of rivers and lakes, and open water in swamps, with a mantle of green, and in these islands is found from the North Cape to Otago, from the central lakes to the sea; yet this also was not mentioned by the earlier botanists; so also *Sparganium simplex*, a common paludal plant in the north, and probably in the south also. Are these and others to be considered introduced on the ground that they were first mentioned by Bidwill or later botanists, or on the possibility that the seeds of some of them might have been brought in various accidental ways?

Zostera marina is a plant the seeds of which could not possibly have been introduced. It is plentiful in the Bay of Islands, Thames River, Mercury Bay, Bay of Plenty, Cook Strait, and in fact all round the coasts where the requisite conditions for its growth exist; it is frequently found floating at a considerable distance from the shore, yet the first positive record of its belonging to the New Zealand flora occurs in the second part of the "Handbook," which is scarcely six years old. Is it to be considered introduced on this ground? Yet it is far more improbable that this plant should have escaped notice than the knot-grass.

It would be easy to place the trivial value of Mr. Travers' argument in a still more forcible light, but it will be sufficient to remark that taking it in its most plausible form it would have no value in the estimation of a botanist well acquainted with the history of botanical discovery, and especially of one possessed of a precise knowledge of the plants actually collected by the earlier botanists.

In writing the above I have tacitly adopted Mr. Travers' assumption that the knot-grass is not mentioned by the earlier collectors in New Zealand, but is this correct? I commend the following extract from Mr. Anderson's remarks on the plants observed by him at Queen Charlotte Sound to the special attention of Mr. Travers. It will be found at page 148 of the first volume of "Cook's Third Voyage," in the well known quarto edition of 1784:—

"Amongst the known kinds of plants met with here, are common and rough bindweed; nightshade and nettles, both which grow to the size of small

trees; a shrubby speedwell, found near all the beaches; sow-thistles, virgin's bower, vanellæ, French willow, euphorbia, and crane's-bill: also cudweed, rushes, bull-rushes, flax, all-heal, American nightshade, *knot-grass*, brambles, eye-bright, and groundsel, but the species of each are different from any we have in Europe. There is also polypody, spleenwort, and about twenty other different sorts of ferns, entirely peculiar to the place; with several sorts of mosses, either rare, or produced only here; besides a great number of other plants, whose uses are not yet known, and subjects fit only for botanical books."

I admit that at first sight the saving clause, "the species of each are different from any we have in Europe," appears to shut out the probability of *Polygonum aviculare* being the plant intended, but upon examining the statement I find that several species are identical not only with continental European plants, but with common plants of the British Islands, and this beyond the possibility of dispute: thus the bindweeds are *Convolvolus soldanella*, and *C. sepium*, the sow-thistles *Sonchus asper*, the bulrushes *Scirpus lacustris* and *Typha latifolia*, the American nightshade *Solanum nigrum*; still further the rushes might have included *Juncus effusus* (*J. tenax*, *b.*, Banks and Sol.), and possibly two other forms common to both countries; so also the crane's-bill and cudweed, although as these are open to question I merely state the possibility. But to what New Zealand plant except *Polygonum aviculare* could the English name of "knot-grass" be applied? Certainly not to any of its close allies, *Polygonum decipiens* would have been called a *Persicaria*, certainly not to the shrubby climbing plants which we now call *Muhlenbeckias*, and which Anderson would have at once separated from knot-grasses, independently of the restricted use of the term by English botanists in all times, by their fruticose, climbing habit, fleshy, shining perianths and polygamous flowers (the small species of this section, *M. axillaris* and *M. ephedroides*, were unknown till discovered by Colenso). *Rumex* is out of the question. I feel confident that any botanist qualified to form an opinion by possessing a good knowledge of the floras of New Zealand and the British Islands will confirm me in stating that with the exception of *Polygonum aviculare* there is no member of the New Zealand flora to which the term "knot-grass" would have been applied by a British botanist of the last century. I do not, however, urge this point, as it seems not impossible to obtain direct evidence on this interesting subject.

To several of the statements made by Mr. Travers exception may fairly be taken. It is, however, only worth while to allude to one, in which he states "the plant is always associated with the immediate occupation of land by man, making its habitation either in places which he has disturbed and then suffered to lie waste, or along the sides of the tracks which he makes over virgin

country." This is highly inaccurate and misleading. I have already stated that in the North Island the plant exists under the same circumstances as those which surround it in the British Islands, manifesting a decided preference for cultivated land, but found also in widely different situations, on mountains and in forests. When the Thames gold-field was first opened, before tracks had been made to any great extent, it was to be seen sparingly in the wildest and most untrodden spots up to 1,900 feet, exactly under similar circumstances to those under which it occurs in the centre of the island, where I had the pleasure of collecting it last summer, and I may state that I have received specimens of the var. *dryandri*, collected with *Veronica tetragona* and other sub-alpine plants on the all but untrodden slopes of Ruapehu and Tongariro by my valued friend, Captain Gilbert Mair.

Mr. Travers' opinion respecting the introduction of *Azolla rubra* will not be generally accepted unless supported by stronger evidence. I shall peruse with interest anything he can offer in support of his theory.

Art. XLI.—*Notes on the Naturalized Plants of the Chatham Islands.* By T. Kirk, F.L.S.

[*Read before the Auckland Institute, 17th August,* 1872.]

Isolated localities offer peculiar facilities for studying the diffusion of introduced plants, and ascertaining their effects in the displacement of native species. In the Chatham Islands this process possesses unusual interest, arising from the striking peculiarities exhibited by the indigenous flora.

The following enumeration of the naturalized plants of this interesting group has been prepared from a packet of dried specimens collected by Mr. H. H. Travers during his recent visit, and kindly communicated by him, together with valuable notes on their relative abundance and diffusion.

From the great distance of these islands from the main land and the comparatively limited amount of intercourse that has taken place, only a small number of species has become naturalized, as will be seen from the appended list. All the species are amongst the common naturalized plants of the colony; but on the other hand the absence of *Nasturtium officinale*, *Senebiera pinnatifida*, *Erodium cicutarium*, *E. moschatum*, *Erigeron canadensis*, *Erythræa centaurium*, *Veronica arvensis*, *V. serpyllifolia*, *Stachys arvensis*, *Euphorbia peplus*, *Festuca bromoides*, and others which have become established weeds from the North Cape to Invercargill, is very striking. It may however be partly accounted for by the comparatively short period during which cultivation has been carried on to any considerable extent, while the limited

amount of intercourse with other places, as already stated, has not afforded much scope for the introduction of many of those viatical plants which follow the footsteps of the traveller. These remarks are illustrated by Mr. Travers' notes; for instance, referring to *Hypochæris radicata,* he writes, "Only found in grass fields in a few localities on the main island," so that it is evidently of very recent introduction, although within the past fifteen years it has become a complete pest in cultivated and waste lands throughout the colony. Most of the plants enumerated are said to occur either in 'grass fields,' 'grassy places,' or 'on abandoned cultivations;' only a single species, *Rumex acetosella,* is said to be generally distributed. All the species are of European origin, with the exception of the prairie-grass, *Bromus unioloides,* which is American, and, from its value as a nutritious grass adapted to a wide range of soil and situation, is proving a welcome addition to our naturalized flora.

Ranunculus repens, L.—Old cultivations on main island.

Fumaria officinalis, L.—Grass fields on both islands.

Capsella bursa-pastoris, DC.—Amongst grass and in bush on both islands.

Sinapis nigra, L.—Common about Waitangi.

Silene anglica, L., b. *quinquevulnera.*—Seen only on Pitt Island; amongst weeds and grasses on a newly made road.

Stellaria media, With.—Common amongst grass on both islands.

Cerastium viscosum, L.—Common amongst grass.

Geranium molle, L.—In grass, chiefly on Pitt Island. (There can be little doubt of this being indigenous, although its area has doubtless been extended by the progress of agriculture, *T.K.*)

Trifolium minus, Sm.—Common amongst introduced grasses.

Sherardia arvensis, L.—Only seen amongst cultivated grasses on Pitt Island.

Bellis perennis, L.—Common in grass fields on main island; not common on Pitt Island; prefers clay land.

Hypochæris radicata, L.—Only seen in grass fields in a few places on the main island.

Sonchus oleraceus, L.—Common amongst grass in both parts of the island. (The specimens are too imperfect to allow of my determining the variety to which they belong, but I am inclined to refer them to *S. asper,* Hoffm., which is certainly indigenous, *T.K.*)

Anagallis arvensis, L.—Common in cultivations; especially on the banks of the great lagoon.

Solanum nigrum, L.—Common in cultivated ground; said to have been brought by the natives from the main land. (Baron F. von Mueller considers this to be of recent introduction; it was, however, collected in New Zealand by Banks and Solander.)

Prunella vulgaris, L.—Common on both islands; especially in water-courses.

Plantago major, L.—Common in cultivations.

„ *lanceolata*, L.—Common amongst grass on both islands.

Polygonum aviculare, L.—Only seen in old cultivations on the main island; not common. (Possibly introduced from the main land, but most probably indigenous, *T.K.*)

Rumex obtusifolius, L.—Chiefly in grass fields on Pitt Island; supposed to have been introduced from Tasmania.

R. acetosella, L.—Common all over the islands, and in all soils.

Phalaris canariensis, L.—Chiefly on Pitt Island.

Dichelachne crinita, Hook. f.—Common; chiefly in old cultivations on Pitt Island. (Certainly indigenous, and has increased in a remarkable manner with the progress of agriculture in the North Island, *T.K.*)

Holcus lanatus, L.—Chiefly in swamps on main island.

Poa annua, L.—Chiefly on Pitt Island, about old tracks.

„ *pratensis*, L., var. *sub-cærulea*.—Common on Pitt Island; not noticed elsewhere.

Dactylis glomerata, L.—In a few places on main island; common on Pitt Island.

Bromus unioloides, Humb.—Most common on Pitt Island.

Lolium perenne, L.—Common on both islands.

ART. XLII.—*Notes on the Flora of the Lake District of the North Island.* By T. KIRK, F.L.S.*

[*Read before the Auckland Institute, 24th June and 22nd July*, 1872.]

TAURANGA.

THE immediate vicinity of the township of Tauranga presents but few plants of interest to the botanist. The naturalized grass *Cynodon dactylon*, the doab-grass of India, forms a dense sward, and during the excessive drought of the last season afforded a good supply of herbage when other kinds were scorched up. *Carduus marianus* is abundant on the cliffs, and in many places the sweet-briar forms troublesome thickets. *Plantago coronopus* is established in one spot on the beach, the only instance so far as I am aware of its naturalization in the colony.

Between Matapihi, on the opposite side of the harbour, and Otupapora the neglected cultivations of the Maoris are literally covered with *Œnothera*

* This paper embodies the results of an examination of the natural vegetation and agricultural capabilities of the district, made by the author for the Geological Survey Department in the autumn of 1872. See also *N. Z. Gazette*, No. 43, 4th Sept., 1872, for official report.—ED.

stricta, which is naturalized to a greater or lesser extent all through the Bay of Plenty, and thence more sparingly to Lake Taupo. This American weed appears to be as incursive in its habits as any of the European viatical plants, and in this district causes much trouble to the natives. The usual arenarian plants are abundant between Otupapora and Maketu, and present but little variety.

MAKETU.

At Maketu *Ruppia maritima* occurs in the tidal portion of the Kaituna river, and fragments of *Potamogeton ochreatus*, Raoul, are floated down the stream. This species has been erroneously referred to *P. compressus*, Sm., and to *P. gramineus*, Sm., and is the sole representative in New Zealand of the grassy-leaved section of the genus. At the mouth of the river is a fine clump of the angi-angi* (*Coprosma baueriana*, Hook. f.), which, according to native tradition, is composed of descendants of the original tree to which the Arawa canoe was made fast on the arrival of the tribe at the island. *Limosella tenuifolia* and *Elatine americana* occur near the beach, the latter attaining here its most easterly known habitat. *Cynodon dactylon* is abundant, and from its capability of resisting drought its diffusion must be beneficial, notwithstanding the pointed objections urged against it by settlers in cultivated districts on account of its poor yield during the winter season. Other naturalized plants are abundant.

The Kawa swamp at Maketu is probably the most extensive habitat for the marsh shield-fern (*Nephrodium thelypteris*, var. *squamulosum*) in the colony. It is here a prominent plant over hundreds of acres. *Nephrodium unitum*, Br., is said to occur about some hot springs in the centre of the swamp, but I had not time to verify the statement. *Calorophus elongatus* is abundant a short distance from Maketu; *Psilotum triquetrum* is found in several spots amongst the tea-tree, and attains its most eastern habitat on Motuhora Island. *Eleocharis sphacelata*, *E. gracillima*, *Cladium articulatum*, and other marsh plants, are abundant.

For a few miles from Maketu the country has evidently formed part of an ancient sea-basin. A littoral grass, *Zoysia pungens*, produces extensive patches of turf, and is sparingly mixed with *Microlæna stipoides*, *Danthonia semi-annularis*, and a few English grasses and trefoils. *Pimelea prostrata*, *Pteris esculenta*, *Pomaderris ericifolia*, *Haloragis micrantha*, *Potentilla anserina*, and stunted manuka, form the chief portion of the scanty vegetation.

On ascending the first hills, about six miles from Maketu, the *Zoysia* at once disappears, but the other grasses named become more frequent, and notwithstanding the sterile appearance of the soil the fern exhibits greater

* Taupata?—ED.

luxuriance; thickets of tupakihi (*Coriaria ruscifolia*, Br.,) are frequent, and of large size. Occasional patches of *Lycopodium densum* and *Pomaderris phylicifolia* are found, but are decidedly rare when compared with their abundance north of the Waitemata. The forest through which the road passes is composed chiefly of *Nesodaphne tawa*, *Metrosideros robusta*, *Podocarpus totara*, *P. ferruginea*, *Atherosperma novæ-zealandiæ*, *Tetranthera calicaris*, *Knightia excelsa*, and *Suttonia australis; Cyathea dealbata*, *C. medullaris*, *Dicksonia squarrosa*, and *D. antarctica* were frequent, in many localities the last named being the prevalent form, and exhibiting a marked extension of its range northwards. *Erechtites prenanthoides* is abundant on moist banks. In places where the forest has been cleared for the line of telegraph a dense rank growth of *Solanum aviculare* and *Fuchsia excorticata* has made its appearance. These plants, sometimes alternating with *Pteris esculenta* and *Gleichenia circinata* are the first to occupy the soil after the destruction of forest in the northern part of the province. Their seeds must often have been lying dormant for lengthened periods as the phenomenon takes place in districts where mature plants are absent or extremely rare.

Rotoiti.

At the pa Mourea, on the narrow strip of land which separates Rotoiti from Rotorua is the largest specimen of *Coprosma baueriana* I have seen. At a short distance it may readily be mistaken for the kohe-kohe (*Dysoxylum spectabile*, Hook. f.) It is said to have been planted by Hatupatu, a chief of the district, who also planted the pohutukawa on the Island of Mokoia, and attempted to naturalize the snapper in the waters of Rotorua, thus on a limited scale anticipating the efforts of the acclimatization societies of the present day. The Ohua stream, which connects Rotorua with Rotoiti, contained masses of *Myriophyllum variafolium*, *Potamogeton*, n.s., *Callitriche muelleri*, *Azolla rubra*, *Lemna minor*, etc. A close growth of uliginal plants occupied the margin of the lake, but presented nothing worthy of special mention. *Glossostigma elatinoides* formed extensive patches in various places, often submerged.

On the high ground above Rotoiti *Poa australis*, var. *lævis*, was first observed but sparingly; on approaching Te Ngae it becomes more abundant, and is intermixed with *Danthonia semi-annularis*, *Microlæna stipoides* and *Leucopogon fraseri*. Its isolated dwarf tussocks become abundant in the small valleys further south, and at a distance present a similar appearance to the northern *Dichelachne stipoides*, so common on sea shores and the margins of mud-flats. In nutritive qualities it is greatly inferior to the typical form which occurs sparingly on the Auckland Isthmus.

TE NGAE.

At the telegraph station, Te Ngae, formerly the residence of the Rev. Mr. Chapman, the false acacia, English elms, elder, hawthorn, poplar, apple, walnut, and other trees, have attained a large size, and are growing with the greatest luxuriance, clearly demonstrating the capabilities of the soil, notwithstanding the sterile appearance of its surface. Introduced grasses also flourish. The sweet-briar has escaped from the garden and become a complete pest; the old road by the telegraph line is so completely overgrown that it is difficult even for horses to thread their way through it. In some parts of the district it is spreading rapidly, the fruit being greedily eaten by horses; the seeds are distributed far and wide. It is easy to foresee that this plant is destined in a few years to effect a considerable change in the scanty vegetation of the whole Taupo district, as similar instances of its diffusion, although in a lesser degree, are not uncommon. The shelter it affords is highly conducive to the growth of native and introduced grasses, which in many spots are destroyed by the scorching summer sun acting upon the pumiceous sand not yet decomposed into soil. Horses, moreover, are said to fatten upon the fruit, so that its spread will not be entirely prejudicial.

ROTORUA.

Rotorua is nearly circular in shape, its greatest diameter being under seven miles. The wonderful volcanic phenomena to which this lake owes its interest are confined to the southern extremity between Te Arikiroa Bay and the Pukeroa stream, and to the Island of Mokoia, which attains the height of 400 feet, and is situated near the centre of the lake. On the south and west sides a low tolerably level plain extends one or two miles to the base of the hills, which attain their greatest altitude, 2,500 to 2,600 feet, at Whangapakau on the eastern, and Ngongotaha, an outlying spur of the Horohoro range, on the south-west; on the north and north-west the country rises more gradually until it reaches the elevated forest-land separating the district from Tauranga and the coast.

In spots where the scrub attains a luxuriant growth the numerous boiling springs and fumaroles are objects alike of interest and danger. The unwary explorer suddenly finds himself on the extreme verge of chasms with vertical sides from three to twelve feet in depth, which are constantly falling in from the action of steam; at the bottom liquid mud in a violent state of ebullition presents a most repulsive appearance. In many mud-springs the contents are less fluid and are occasionally ejected with considerable force; in others the contents appear to be about the consistency of putty, with the surface undisturbed, a bubbling sputtering noise is heard, and in a moment the centre of the mass rises in a somewhat domed shape until it breaks from the apex in

masses more or less regular, which still retain their plasticity, and as they gradually expand towards the circumference of the pit assume the appearance of decorative leather-work on a large scale, until becoming thinner they are gradually absorbed in the general mass. All degrees of consistency are to be found. No vegetation was observed on the walls of mud-springs, although the sides of simple boiling-springs, when not too violently agitated, were usually covered with a dense growth of fern or club-moss. At Whakarewarewa, on the south-east, are mud-volcanoes with elevated cones, which are constantly overflowing, and a series of intermittent geysers, fumaroles, and boiling springs, with terraces second only to those of Rotomahana, but the locality is seldom visited by tourists.

As may be readily imagined from the foregoing sketch, the conditions under which vegetation exists are not favourable to the development of a luxuriant flora, and it is especially worthy of note that throughout the whole of the Taupo country the number of naturalized plants is disproportionately small as compared with other districts, even when all allowance is made for the slow progress of settlement; it is, moreover, largely composed of species introduced by the missionaries for cultivation, mere garden escapes, as the stramonium, fennel, potato, strawberry, peach, cherry, tobacco, purslane, elder, horehound, sweet-briar, *Lycium barbarum*, etc., only a few of which are extensively distributed, the majority marking the sites of deserted cultivations.

Near Te Arikiroa Bay a dense growth of *Dracophyllum urvilleanum*, *Leptospermum scoparium*, dwarf states of *L. ericoides*, etc., prevails to such an extent that it is difficult to force one's way to many spots. Where the surface of the soil is more decomposed *Gaultheria rupestris* occurs sparingly; about the boiling pool, Oruawhata, the scrub is much more luxuriant, and mixed with *Coprosma lucida*, etc. *Datura stramonium* is abundantly naturalized on the sulphur sand of the beach towards Ohinemutu, in some places growing with *Lycium barbarum*. On the low land at the back of Ohinemutu, much of the vegetation is stunted and diminutive. Amongst the manuka may be found two plants which here approach their northern limit—*Gnaphalium filicaule* and *Lycopodium magellanicum*. A *Carmichælia*, which in the absence of flowers I refer to *C. juncea*, Col., is occasionally met with. *Lycopodium densum*, *L. laterale*, *Celmisia longifolia*, *Geum strictum*, *Potentilla anserina*, *Viola cunninghamii*, *Hydrocotyle novæ-zealandiæ*, *Botrychium virginicum*, *Thelymitra pulchella*, *Alternanthera sessilis*, *Epilobium tetragonum*, *E. billardieri*, *E. alsinoides*, *Pimelea prostrata*, with patches of *Agrostis æmula*, *Microlæna stipoides*, mixed with *Cynodon dactylon*, and other naturalized grasses, are the chief plants found in this vicinity. *Cladium junceum*, *C. gunnii*, and similar plants are abundant in the swamps and wet places; *Eleocharis sphacelata* and *Sphagnum squarrosum* occupied the whole of one large swamp.

The Pukeroa stream contained exactly the same plants already mentioned as having been collected in the Ohura. *Elatine americana*, with various uliginal plants, fringed its banks. One or two small patches of kahikatea form the only timber on the low lands.

The summit of Ngongotaha and the adjacent hills is clothed with luxuriant forest, the margins of which have been from time to time cleared by the natives for their scanty cultivations. The chief trees are the rimu, rata (*Metrosideros robusta*, Sm.), tawa, rewa-rewa, mangiao, and pukatea; the puka-puka (*Brachyglottis repanda*, Forst.) and *Coprosma grandifolia* are abundant, and especially *Alseuosmia macrophylla*, which forms the densest of the undergrowth down to 1,700 feet. *Senecio glastifolius* and *Drimys axillaris* are comparatively rare. *Griselinia lucida* and *Pittosporum cornifolium* occur as epiphytes with *Astelia solandri* and *A. cunninghamii*. *Cyathea medullaris*, *C. dealbata*, and *Hemitelia smithii* are frequent, and a few noble specimens of *Dicksonia antarctica* occur near the summit, but as a rule the paucity of species extends to ferns, no less than to phænogamic plants.

The open country towards the north end of the lake presents still fewer plants of interest; *Dracophyllum subulatum*, Hook. f., the most characteristic plant of the Taupo plains, attains here its northern limit. Near the point where the road to Tauranga crosses the Kotukuroa creek, two or three bushes of a large-leaved *Pittosporum*, four to six feet high, were observed with immature fruit. In the absence of flowers, I identified the plant with *P. tenuifolium*, var. *fasciculatum*, although the peduncles are erect. *Lycopodium magellanicum*, which attains its extreme northern boundary a few miles nearer Tauranga, was plentiful; when growing luxuriously, as in the present instance, it is a far more graceful plant than its European representative *L. clavatum*, L., and presents a totally different appearance to the stunted condition common on high open lands. *L. scariosum* covered the rocks with its long pendent stems, the bright yellow spikes harmonizing well with the deep green leaves. *Gaultheria oppositifolia*, Hook. f., was plentiful in one spot, although the specimens had a stunted appearance; with *Craspedia fimbriata*, DC., it attains its northern limit in this habitat.

The forest on this side presented few plants of interest when compared with the forests of the northern part of the province, and was remarkable from the absence of kauri, tarairi, and puriri. The hinau, rata, (*Metrosideros robusta*, Sm.) matai, miro, tawa, mangiao, and rewa-rewa are abundant. *Weinmannia racemosa*, *Santalum cunninghamii*, and *Ixerba brexioides* are much less frequent, but I have reason to believe that on the Tauranga side the number of species is much larger.

To return to the lake, on the north side I was surprised to find on the beach the littoral plants *Bromus arenarius*, Lab., *Carex pumila*, Th., *Scirpus*

maritimus, L., and *Ranunculus acaulis*, with patches of *Zoysia pungens*, Willd. *Deschampsia cæspitosa*, Palisot, attains its northern boundary at this part of the lake. About hot springs at Ohinemutu a *Chenopodium* occurs with the leaves farinose beneath, which in the absence of flowers or fruit I refer to *C. ambiguum*, notwithstanding the sub-erect flaccid habit. *Leptocarpus filiformis* is abundant with *Cladium junceum* in a hot-water swamp. *Viscum salicornioides* occurs sparingly on *Leptospermum ericoides*, etc., in several places near these springs, and flourishes in the steamy atmosphere.

A few plants flourish on the heated mud, *Limosella tenuifolia* and *Glossostigma elatinoides* exhibit remarkable luxuriance when the roots enjoy a temperature of 90° to 95° Fahr. *Scirpus lacustris* flourishes in one or two spots with a temperature of 93° at the roots, but in others it appears scalded and stunted at a much lower root temperature, probably the result of a sudden increase in the temperature of the surrounding water. *Fimbristylis dichotoma* is a most abundant plant in Ruapeka Bay, and is to be seen everywhere, flourishing with a root temperature of 95°, whether growing on heated mud or where a faint steam jet has broken through the crust. In these situations it exhibits the greatest luxuriance, and contrasts forcibly with the pigmy specimens growing in soil of the ordinary temperature. It is abundant near the so-called sulphur sea, Te Arikiroa Bay, but so diminutive that it might readily be passed without attracting notice, notwithstanding its peculiar habit, and in size and development exactly resembling specimens collected at Peringa and Te Pakaruna in the Lower Waikato. It is probable that the plant has been conveyed to those habitats by Maoris travelling to the Waikato Heads.

Lycopodium cernuum, L., a common plant about hot springs in all parts of the world, is more abundant at Ohinemutu, often lining the sides of hot pools and luxuriating amongst steam jets, its roots must often endure a much higher temperature than 95°, but from accidental causes I was unable to continue my observations in this direction. *Pteris incisa*, Thunb., was usually associated with the *Lycopodium*, and showed a like partiality for a warm atmosphere. Perhaps the most singular plant found in these situations is the terrestrial Alga, *Chroolepus aureus*, Mitt., which is abundant on dead twigs, fern-stalks, etc., its clotted orange-brown filaments being often conspicuous at a considerable distance. Wherever the traveller descries this singular Alga in the brushwood before him he has a sure indication of the close vicinity of a boiling mud-spring, or of heated vapours escaping from treacherous ground, and should at once walk warily. The filaments of specimens from this locality are much longer than in northern specimens.

The absence from the Ohinemutu district of any of the tropical ferns found in the vicinity of the hot springs further south is a singular circumstance, for which no explanation can be offered at present. On the other hand, the

restricted distribution of *Fimbristylis dichotoma* is no less remarkable. With one exception it is confined to the hot springs of Ohinemutu. At Otumakokori, where it occurs very sparingly, it has doubtless been carried by travellers within a very recent period.

The appended list of plants shows the paucity of the flora found in the immediate vicinity of Ohinemutu; including naturalized plants it numbers less than 300 species.

Tobacco is extensively cultivated by the Maoris about Ruapeka Bay, in small inclosures containing from 10 plants to 400, which are usually kept in the greatest order and neatness, the leading shoot being carefully pinched back as soon as the fourth or fifth leaf is fairly developed. Tobacco might be grown to a large extent in this district, and as the dried leaf sells wholesale for one shilling per lb. in Auckland, the natives might readily secure a considerable income. Unluckily, however, they have no idea of the dignity of labour, and confessedly rank amongst the least industrious of their race.

ROTOKAKAHI.

The country between Whakarewarewa and Rotokakahi presents few objects of special interest, although the soil is more fertile than in the vicinity of Ohinemutu, and much of the vegetation more luxuriant. At Pareru the road runs through a small piece of bush in which *Dicksonia antarctica* is abundant, its massive column-like stems and umbrageous fronds present a most imposing appearance. I cannot assent to the correctness of Sir William Hooker's conclusions in uniting *D. lanata*, Col., with this species;* to me they appear to be abundantly distinct, the peculiarities of each being clearly developed even in diminutive specimens.

In the narrow vallies *Poa australis* var. *lævis* is abundant, occasionally mixed with *Sporobolus elongatus*, *Microlæna stipoides*, and several introduced grasses. *Dracophyllum subulatum* is abundant in certain localities, *Pomaderris phylicifolia* and *Lycopodium densum* become very local, and are not observed south of the Waihorepa Valley, although I believe both these plants have an outlying locality in the South Island.

In a stream fed by a small swamp near the southern extremity of Rotokakahi, *Montia fontana*, L., occurs in great plenty. This is probably the northern limit of this widely distributed plant, which is here associated with its European congener *Lemna minor*. I estimate the altitude of the locality at under 1,500 feet.

Rotokakahi presents but little variety in its vegetation, especially amongst the aquatic section. The fistulose form of *Crantzia lineata* occurs in from one to seven feet of water, as does a small *Myriophyllum*, which is probably

* See Art. XLIII.

undescribed. *M. variæfolium* is found in several spots. *Isoëtes kirkii*, H. Br., appears to be rare, but the water was too rough to admit of a thorough search being made. A scanty growth of *Scirpus*, *Cladium*, *Eleocharis* and *Carex* is found at a few places in the margin, backed by a sparse growth of shrubs and small trees, chiefly *Metrosideros robusta* and *Weinmannia racemosa*. Several fine karakas occur on the Island of Motukawa. In many places the rocks are elegantly clothed with masses of *Bolbophyllum pygmæum*, *Earina autumnalis*, *Dendrobium cunninghamii*, *Trichomanes reniforme*, *Hymenophyllum rarum*, etc. *Hydrocotyle heteromeria*, DC., which occurs in abundance with the naturalized *Mentha viridis* at the north-east end of the lake, is worthy of special notice. *Gaultheria oppositifolia* Hook. f., one of the rarest and most handsome flowering shrubs, covers a cliff near Kaitiiiria, and must present a noble appearance when in flower in the beginning of January. *Barbarea præcox*, *Portulaca oleracea*, *Verbascum thapsus*, and other naturalized plants occur near the native settlement and in other localities near the lake. The hills are chiefly covered with fern, often luxuriant, and intermixed with native and introduced grasses, often to a considerable extent. The only outlet of the lake is by the Wairoa River, which, after a descent of 300 feet, finds its way into the Tarawera Lake.

TIKITAPU.

Tikitapu, the "Little Blue Lake," is separated from Rotokakahi by a low ridge; crateriform in appearance, it has no visible outlet, and is probably connected with Rotokakahi by a subterranean channel; it is the most picturesque lake in the district, and owes much of its attractiveness to the magnificent forest which clothes the hills on its northern and western sides. An undescribed *Cladium* and a new species of *Myriophyllum* were collected here. *Tupeia antarctica* is frequent, being usually parasitic on *Panax arborea*, and from the unusual yellow tint of its leaves was conspicuous at a considerable distance. Immense specimens of the rata were abundant in the forest. *Hemitilia smithii*, *Dicksonia squarrosa*, and other tree ferns, attained an unusual height. *Davallia novæ-zealandiæ* was remarkably luxuriant, its fronds often being from four to five feet in height, but with all this luxuriance of growth the paucity of species, when compared with the rich forests of the north, continually forced itself into notice.

The raupo (*Typha latifolia*) occurs in small quantity at the north end of the lake; it is so extremely rare in the district, that the whares are usually constructed of sedges and grasses, even *Poa lævis* being employed for this purpose.

In the Wairoa Valley, between Rotokakahi and Rototarawera, the pansey (*Viola tricolor*) and other garden plants are abundantly naturalized, doubtless

escapes from the mission gardens. Amongst dilapidated buildings in the native settlement of Hereapauki the European ivy is flourishing with a degree of luxuriance I have not seen elsewhere in the colony.

TARAWERA.

Lake Tarawera is of irregular shape, its greatest diameter being, from east to west, about seven miles; it receives the discharge of Rotokakahi, Rotomahana, and three smaller lakes; its outlet being by the Tarawera River, which leaves the lake at its eastern extremity and falls into the sea at Matata. It is more or less margined by cliffs often clothed with pohutukawa, especially at the southern arm Te Arikiki, which forms the flank of the Tarawera mountain. In this arm the pohutukawa is abundant, and attains a development only inferior to that which it exhibits in sheltered bays in the northern parts of the province. I was informed by Captain Gilbert Mair that it occurred along the course of the Tarawera River to Matata. In the same bay, at the mouth of the warm river, the Kaiwaka, are hot springs, about which *Chenopodium ambiguum* occurs, having a strong tendency to the semi-erect habit of the Ohinemutu plant. A flat-leaved state of *Potamogeton pectinatus* is floated down the Kaiwaka from the warm lake, but I was unable to discover it *in situ*. The angi-angi (*Coprosma baueriana*) occurs in the vicinity of deserted native settlements, but evidently planted. *Ophioglossum gramineum* is found on rocky ledges on the cliffs under Tarawera mountain; its bright yellow spikes, often washed by the waves, were conspicuous at a considerable distance. Masses of submerged *Myriophyllum* and *Isolepis* were abundant in the clear water, while the cliffs, clothed with masses of *Astelia trinervia* and the littoral *A. cunninghamii*, overshadowed by pohutukawa of dimensions that would have gladdened the eyes of a shipbuilder, and laden with epiphytic ferns and shrubs—*Griselinia lucida, Pittosporum cornifolium*, and *Astelia solandri*—presented near the centre of the island a fac-simile of scenes only to be found elsewhere in the northern part of the province; but with this marked difference, the aquatic plants were fluviatile, not marine.

Ascending the warm river, floating masses of *Potamogeton pectinatus* were constantly met, and large submerged tufts of *Isolepis setosus*. *Lemna minor*, with larger fronds than usual, formed small floating patches in quiet places. A dense growth of sedges occupied the swamp on either side, amongst which the tropical *Nephrodium unitum* grows in vast abundance, covering acres with its dull green fronds which are sometimes five feet high and seven inches across, but in this state are usually barren. It is easily picked from the canoe when ascending the rapids, which mark the upper part of the stream. *Viscum salicornioides* and *Loranthus micranthus* are not unfrequent on the tea-tree in the swamp, which contains few plants worthy of special notice.

Rotomahana.

Rotomahana is of small size, its greatest diameter being less than a mile. From the numerous swamps which surround it, the absence of wood, the dirty green colour of the water, and the stunted aquatic vegetation which certainly exists under unfavourable circumstances, the first view of this remarkable lake is strangely disappointing. But in a moment all this is forgotten, as landing from the canoe the traveller walks round a projecting point of the swamp and stands at the base of Te Tarata. This paper is, however, concerned only with the vegetation of the locality, and the conditions under which it exists.

The height of the terraces of Te Tarata is about eighty feet; at its base is a small clump of *Leptospermum* growing amongst *Cladium junceum* and other uliginal plants. *Nephrodium unitum* occurs sparingly, and by careful search a stunted specimen of *Gleichenia dichotoma*, another tropical fern of wide distribution, may perchance be found. *G. circinata* is abundant. Ascending the terraces until the verge of the geyser is reached, *Pteris incisa, Lycopodium cernuum, Dianella intermedia, Leucopogon fasciculatum, Haloragis micrantha, Leptospermum ericoides, Gleichenia circinata,* and var. *dicarpa,* are found occupying a small rocky knob from which the troubled surface of the fountain may be viewed in safety. The steep upper lip which forms the opposite side of the crater is clothed in many places with a dense growth of *Lycopodium cernuum*, large patches of which exhibit a scalded appearance, as if from the effects of over-heated steam. On the opposite side of the terraces *Nephrodium unitum* covered the thin crust overlying the scalding mud, and from its erect, rigid habit, and strict sori-laden pinnules, presented a forcible contrast to the luxuriant swamp form previously described. Its rhizomes are massed together in dense masses, sufficiently firm to bear the weight of a man, and produce fruited fronds from two inches to two feet high in countless thousands.

Proceeding for some distance along the shore of the lake and ascending the hill side nearly opposite Rotokiwi the entrance to a small glen known as Rotokanapanapa is attained, and after crossing a patch of steaming mud amongst miniature mud-volcanos in an active condition, the little green pond from which the glen takes its name is seen; its green colour is doubtless due to the presence of a minute *Conferva.* The sides of the glen in many places are dotted with steam jets which have destroyed much of the vegetation. In this remarkable habitat *Gleichenia dichotoma* attains a luxuriance not to be seen in any other locality in the colony. Where sheltered by low scrub it reaches the extreme height of from five to six feet, and is repeatedly branched. In exposed places it is restricted to a single pair of simple pinnæ, but in all cases it is marked by the small accessory pinnæ at the base. In several instances steam jets had burst through spots occupied by this fern, and

destroyed patches of it two or three feet in diameter. The temperature endured by the roots must have been over 100° Fahr. In one spot the ground gave way under my feet, when a steam jet immediately broke through and destroyed the fern all round. My natives did not approve of fern-collecting in such situations, and for the most part contented themselves with looking on, occasionally giving a warning cry of danger as an apology for their laziness. The steamy atmosphere in which the plant grows in this habitat rendered the specimens so extremely delicate that many of them shrivelled during the short period occupied in carrying them to our camp. *Psilotum triquetrum*, in a similar condition as regards delicacy of texture, was collected in several spots in the glen. *Microtis porrifolia* and *Orthoceras solandri* were common amongst the stunted manuka in open places.

ROTOKIWI.

At Rotokiwi a curious instance of the effects of the moist, heated atmosphere on plant-growth was observed. A specimen of *Leptospermum ericoides*, twenty feet high, overhung a boiling spring on the side of the terrace in such a manner that the branches were exposed to the heated steam without being scalded. The tips of the branches had been punctured by a small insect, but instead of giving off from each gall a few stunted shoots with aggregated leaves almost without vitality, as is usually the case under such circumstances, a vigorous growth of long slender branchlets had been produced, so that the affected branches had been transformed into handsome green plumes, and had apparently overcome the injury instead of succumbing.

At Otukapurangi, the terraces of which impressed me with a sense of their stately magnificence far more than those of Te Tarata, the whole of the adjacent vegetation had been recently burned, so that the entire fountain was naked and bare. One or two tufts of *Nephrodium unitum* were growing on the lower terraces, but no other plants worthy of notice were observed.

The New Zealand form of *Lastrea thelypteris* occurs in the swamp on the south margin of the lake, and in the lake itself *Eleocharis sphacelata*, *Scirpus lacustris*, and *Cladium articulatum*, but all appear more or less scalded, as if occasionally affected by a sudden increase in the temperature of the water.

Amongst floating *Conferva*, on the west side of the lake, I discovered a pretty bladder-wort, new to science, in general appearance it resembles *Utricularia intermedia*, Hayne, but has the bladders attached to the leaves; unfortunately it was long past flowering, and from its general appearance I am inclined to believe that it also resembles *U. intermedia* in producing flowers but rarely.

The restriction of *Nephrodium unitum* to the vicinity of the hot springs and the warm water swamp between the two lakes, with the limitation of

Gleichenia dichotoma to a single habitat, are significant facts, but I defer further remark on this head until referring to their distribution in the Taupo district. It is extremely difficult to account for the absence of all notice of *Nephrodium unitum*, as it occurs in vast abundance in situations where it could not possibly have been overlooked by the numerous travellers who have visited the lake. *Gleichenia dichotoma*, originally discovered in this locality by Captain Gilbert Mair, although far more striking in general appearance, may easily have been passed by, owing to the difficult and unlikely nature of its habitat. Although this fern was first described as a native of New Zealand by Forster, it has been generally considered that he did not collect it in these islands. Its discovery at Matata, on the East Coast, however, throws a new light on the subject, and suggests the possibility of its having been collected by him at some other isolated locality in the Bay of Plenty or in Poverty Bay, although its inclusion amongst the plants used by the Maoris as food is probably an error.

Tarawera Mountain.

The land between the eastern extremity of Tarawera Lake and the base of Tarawera mountain is much broken by deep ravines with precipitous sides. The majority of these are filled with *Leptospermum* and other common shrubs, the most prominent being large-leaved forms of *Pittosporum tenuifolium*. Much of the open portion had been burnt shortly before my visit, and in many spots the surface was hidden by a young growth of common *Danthonia* and *Agrostis quadriseta*, the latter excessively rigid and scabrid. The base of the mountain is strewed with masses of fallen rock, amongst which a few common shrubs are growing in a more or less stunted condition. Large terrestrial specimens of *Metrosideros robusta* occur at the entrance to the gorge separating Ruawahia from Te Wahunga. The ascent of the central portion, Ruawahia, is attended with some little difficulty on account of its precipitous character, and the danger arising from loose fragments of rock which become detached with the slightest touch. Single aneroid observations gave rather less than 2,500 feet as the height of the central peaks above the lake level; this added to the usually received altitude of the lake gives a result nearly identical with that published by the Director of the Trigonometrical Survey from corrected observations, 3,609 feet.

The vegetation on the face of the mountain is scanty and stunted, but notwithstanding the arid nature of the situation diminutive specimens of *Hymenophyllum bivalve* and other species occurred in crevices. *Astelia trinervia* grew in sheltered places up to 3,200 feet, with *Gaultheria oppositifolia* and *Cyathodes acerosa*, etc. A dwarf shrubby vegetation occurs in sheltered places on the summit, and affords cover for a luxuriant growth of

mosses and lichens, in which the epiphytic *Chiloglottis traversii* attains its northern limit in company with the common *Thelymitra longifolia* and *Orthoceras solandri.* *Raoulia monroi* attains here its northern limit, and forms small patches on the bare surface, but of so inconspicuous a character that it might easily be overlooked but for the white silky hairs displayed by the recurved margins of the leaves. *Olearia furfuracea* and *Corokia buddleoides* have not, I believe, been recorded from a more southern locality, or a greater altitude. *Dracophyllum longifolium* occurs sparingly, and attains its northern limit; it has not previously been recorded as occurring in the North Island. *Panax colensoi* is the most prominent shrub, forming handsome dwarf bushes, widely different from the small tree-like habit it assumes at its northern limit on the Cape Colville ranges. It affords a welcome shelter to *Hymenophyllum bivalve*, *H. multifidum*, and a few other ferns more or less common; the total number of species collected above 3,000 feet did not exceed seventy, but owing to the approach of night I was able to examine a small portion of the central range only. Still, making every allowance, the vegetation of the mountain comprises a remarkably limited number of species.

WAIHOREPA.

The Waihorepa valley, about two miles from Kaitiriria, appears to have been the bed of an ancient lake, and is remarkable for the singular fissures and holes which break its surface, and have probably been caused by earthquakes. The most striking of these fissures extends for more than half a mile, although much interrupted, and in the deepest places affords a favourable habitat for several plants of a southern type. *Clematis colensoi*, *Cyathodes empetrifolia*, and *Lomaria alpina*, probably attain their northern habitat in this singular locality. *Craspedia fimbriata* grows to a large size, and the charming terrestrial orchid *Corysanthes rotundifolia* is found sparingly. The luxuriant vegetation of the fissures contrasted forcibly with the dried grasses and stunted shrubs which marked the level of the plain, where the only plants worth notice are *Dracophyllum subulatum* and *Poa australis*, var. *lævis*, with tufts of *Celmisia longifolia*, which is known all through the district as "cotton-grass."

OTUMAKOKORI.

At the foot of the Paeora range several tropical ferns exhibit the greatest vigour and luxuriance in an atmosphere of heated steam on the banks of the Otumakokori—the boiling river. Near the source of this remarkable stream are a number of boiling springs, some of which have their origin in cavern-like recesses, others in holes eight to fifteen feet in depth, boiling wells in fact, but most of them sufficiently large to allow of their investigation by anyone

disposed to incur the risk of descending their steep sides and slipping into water of a temperature much above 200° Fahr. Many of these springs yielded clear water, in others it was slightly turbid; but, unlike the springs of Rotomahana, there was no incrustation. All the springs discharge into the bed of the stream, which in the upper part is confined by rocky banks, between which the boiling river forces its way with great impetuosity, giving off clouds of vapour. A short distance below the springs the stream is crossed by a natural bridge, from which a charming view is obtained of the rushing torrent.

In no other locality in the district are the effects of a moist, warm atmosphere on vegetation so forcibly shown. The rocky banks of the stream and the sides of the boiling wells are abundantly clothed with a growth of *Lycopodium cernuum*, varying in luxuriance with the temperature to which it is exposed; flourishing where the temperature varies from 70° to 95° but forming dwarf compact masses covered with depauperated spikes at a higher degree. *Pteris scaberula* is abundant on the banks of the stream, but except in cool situations is excessively depauperated, forming a striking contrast with the luxuriant *P. incisa*, which flourishes in the heated steam. *Gymnostomum tortile* and other mosses exhibit a peculiar elongated and attenuated appearance, widely different from their normal forms, and do not produce fruit.

The tropical *Nephrodium molle* occurs sparingly in this, its only New Zealand habitat, evincing a decided preference for the sides of the deepest and least accessible boiling wells, but also growing in situations where it must experience a greatly reduced temperature, occasionally the pinnæ were singularly rounded and abbreviated, but covered with sori. The texture of its fronds is so extremely delicate that they are bruised by a light shower. *Nephrolepis cordifolia*, Baker, is found in great abundance chiefly amongst moss by the banks of the stream; in the excessively high temperature in the immediate vicinity of the boiling springs the fronds are not above six inches in length, and of a peculiar strict and rigid habit of growth, producing sori but sparingly; lower down the stream the fronds are more than two feet in length and of elegant habit, producing sori freely; the wiry, fibrous roots never produce tubers, as is the case in Mexico and Brazil.

Gleichenia dichotoma, Willd., is plentiful about the boiling wells in places where the roots have the advantage of a high temperature, but does not occur on the lower parts of the creek. *Nephrodium unitum*, Br., is found sparingly about the springs and in the swamp below, but in nothing like the profusion it exhibits at Rotomahana and other places.

Fimbristylis dichotoma, Vahl., occurs sparingly, but is probably of very recent introduction by travellers from Rotorua.

Otumakokori is the only known habitat in New Zealand, in which the tropical ferns here enumerated occur together. *Nephrodium molle* is not found elsewhere, and *Nephrolepis cordifolia*, although growing in another locality, is only found there in small quantity and in a depauperated condition. *Gleichenia dichotoma* and *Nephrodium unitum* are found in several localities, and exhibit a comparatively wide range when contrasted with the *Nephrolepis* and *Nephrodium molle.*

It is remarkable that Dr. Hochstetter, who first discovered *Nephrolepis cordifolia* and *Nephrodium molle* in the colony, does not mention the existence of *Nephrodium unitum*, or of *Gleichenia dichotoma*, one of the most striking ferns in the New Zealand flora.

About half a mile from its source the Otumakokori passes through a swamp; for some little distance along its margin *Nephrodium unitum* occurs sparingly, rarely accompanied by a solitary plant of *N. molle*, and more frequently by handsome specimens of *Nephrolepis cordifolia*, but neither of these plants is found beyond the influence of the warm water. Amongst the numerous uliginal plants which are found here *Gunnera prorepens* deserves special mention. The specimens observed were perfectly glabrous, possibly from growing in a much higher temperature than usual.

PAEORA RANGE.

The forest which clothes portions of the Paeora range presents few plants of special interest and exhibits but little variety. The rata (*Metrosideros robusta*) is abundant, and in several localities, as at Waiwhakahihi, forms extensive groves, every tree being of purely terrestrial origin; specimens of epiphytic origin are only to be found in the dense lowland forest, and diminish in frequency as the tree approaches its southern limit.

Scattered plants of *Senecio lautus* are to be met with in the Paeora and Ratoroka vallies, and in other places in the Taupo district. It is of much more spreading and succulent habit than when growing on the sea shore, and might be mistaken for *S. odoratus* but for the smaller rays.

The pigmy *Isolepis aucklandica* is found sparingly in one or two localities, but is remarkably local; its northern boundary is probably attained at about a mile east from Otumakokori, at an estimated altitude of 1,500 feet.

ORAKEIKORAKO.

At Orakeikorako the naturalized watercress is abundant on the margin of the Waikato River, and affords a welcome addition to the scanty supply of fodder to be procured in that locality. The banks on both sides of the river are marked by innumerable steam jets, ngawhas, fumaroles, and geysers to such an extent that the utmost vigilance is necessary on the part of the explorer to prevent accident. About the hot springs *Gleichenia dichotoma*

occurs in immense abundance, although from growing in exposed situations it does not exhibit the extreme luxuriance which it displays at Rotomahana, and produces sori but sparingly. *Schizæa dichotoma* and *Psilotum triquetrum* attain here their southern limit, their occurrence being due to the influence of the boiling springs in modifying temperature. In the north the *Schizæa* is usually found about the roots of the kauri. *Schizæa bifida* occurs sparingly and in a depauperated condition, apparently suffering from the increased temperature. *Juncus maritimus* grows in great abundance amongst the hot springs on both sides of the river, but I am not aware that this characteristic littoral plant has been found in any other inland habitat except Ohinemutu. *Lepidosperma concava* is found in great abundance and vigour on the right bank of the river, but appears to be confined to a solitary habitat, the only one known south of the Thames.

The famous alum cave at Orakeikorako is merely a deep hole sloping downwards from the face of the rock and containing a boiling spring which forms aluminous incrustations on the rocks within its influence, but the cave itself is chiefly remarkable for the richness and beauty of the plant-growth by which it is concealed. The face of the rock above the mouth of the cave is covered with a profusion of a slender climbing rata, *Metrosideros hypericifolia*, many of its sub-pendent branches supporting a growth of drooping mosses and scale mosses. The mouth of the cave is filled by striking specimens of the silver-tree fern (*Cyathea dealbata*) and the weki (*Dicksonia squarrosa*), their delicate tracery producing a most exquisite effect when viewed from the lower part of the cave. Several small ferns of great beauty cover portions of the mouth and detached rocks with a tapestry of the tenderest green, one of the most conspicuous being *Lindsæa trichomanoides*, which, although singularly local in the district, occurs here in profusion.

The Maoris have made sufficient progress in civilization to attach a money value to "show-places." At the time of my visit posts had been fixed for the erection of a gate which I was given to understand would be kept locked so as to prevent pakehas from visiting the cave until a payment of fifteen shillings had been extorted from each. It is to be desired that visitors on such terms may be few and far between!

Oruanui.

At Oruanui is an extensive forest, chiefly remarkable for the large amount of totara which it contains. Many of the trees are of large dimensions and excellent quality. The contractors for the telegraph are said to have procured the chief part of the timber used in the district from this locality. The small patches of forest on the hill sides contain a large proportion of matai and miro, and less frequently kahikatea.

The open plains present but few plants of interest; patches of *Raoulia hectori* and *Muhlenbeckia axillaris* are found in one or two localities south of Oruanui and attain here their northern limit. *Carex inversa* occurs sparingly in dry sandy places, the culms being extremely slender. *Isolepis aucklandicus* and *Lomaria alpina* are found sparingly in moist, sheltered spots. *Dracophyllum subulatum* is common on plains throughout the district.

WAIKATO RIVER.

Crossing the Waikato, near the northern extremity of Lake Taupo, much of the low scrub at a short distance from the river banks is seen to be stunted and depauperated; the cotton grass (*Celmisia longifolia*) forming large masses on the spots that appear too barren to allow the growth of *Poa lævis.* By the road side at Waipihi, and in other places on the margin of the lake, attention is at once arrested by the heavy growth of littoral plants, *Chenopodium ambiguum* and *Convolvolus soldanella.* The pohutukawa also is found on the Island of Motutaiko, and I believe in several places on the shores of the lake, but is nowhere so abundant or of such large dimensions as at Lake Tarawera.

OPEPE.

About Opepe most of the hills are capped with patches of forest in which the totara, miro, matai and kahikatea are the most common trees. *Elæocarpus hookerianus* is also abundant, and attains a large size. *Griselinia lucida* is also common, and in this locality affords support to the larvæ of *Hepialus virescens,* the so-called vegetable caterpillar, which offers a nidus for the curious fungus, *Cordiceps robertsii.* Many rare ferns, as *Lomaria patersonii, Todea superba, Lomaria alpina, L. vulcanica, Dicksonia antarctica,* and *D. lanata* are found in great abundance. *Panax sinclairii, Gentiana montana,* and *Coriaria thymifolia,* the ground tute of Otago, attain here their northern limits. The small indigenous form of *Leontodon taraxacum* and *Viola filicaulis* are also found in abundance.

The exceptional position of the forest is doubtless the result of denudation. The hills have been formed by successive pumiceous deposits, the more recent of which have been washed from the higher lands, so that the older submarine deposits, which are more or less decomposed, have been laid bare to a greater or lesser extent, and are now covered with a vegetation not only of luxuriant growth but comparatively rich in the number of species which it contains.

The low grounds are intersected by deep gullies and ravines, produced by sub-aerial denudation, which are often of great depth, and in some cases filled with a dense vegetation presenting but little variety. An inconspicuous *Haloragis,* new to science, occurs profusely in these situations.

MOTUKINO.

At Motukino I observed a few specimens of *Gaultheria fagifolia*, which was originally discovered by Mr. Colenso in this locality and has not been found elsewhere, so that it must be considered one of our rarest plants. Not more than five or six plants were observed, all of which were long past flowering; its fruited racemes were sometimes three inches in length, but the calyx was in all cases unchanged. Although remarkably different in appearance from *G. antipoda*, its habit and general aspect suggest the possibility of its being an hybrid between that species and some form of the protæan *G. rupestris.*

Other rare or interesting plants collected here, *Melicytus lanceolatus, Panax anomala, Santalum cunninghamii*, all of which occurred sparingly. *Gleichenia cunninghamii* was abundant in a solitary habitat. *Raoulia monroi*, and *R. hectori* were rare and local. *Asplenium colensoi* was found in a solitary habitat—the ditch of an ancient pa—but in a depauperated condition, the largest specimen not being more than two inches in height; the habit and colour of this plant contrasted forcibly with the associated *A. hookerianum. Lycopodium selago* was observed for the first time in the North Island, and with *Cassinia vauvilliersii*, attains here its northern limit.

The occurrence of littoral plants in the numerous inland localities stated in this paper, affords the strongest support to the theory of the submarine origin of the central portion of the island, so far at least as the lower lands are concerned. I had occasion to draw attention to this subject when treating on the botany of the Lower and Middle Waikato districts, and have pleasure in recurring to it, as it demonstrates most forcibly the importance of geological change as an agent in the distribution of vegetable life, a fact which has been almost lost sight of by phyto-geographical students.

The following littoral plants were collected :—

Ranunculus acaulis, Banks & Sol.—Rotorua, Tarawera Lake.

Metrosideros tomentosa, A. Cunn.—Tarawera Lake, abundant, and of large size; Lake Taupo.

Convolvolus soldanella, L.—Shores of Lake Taupo, abundant.

Chenopodium glaucum, L. var. *ambiguum.*—Rotorua, Tarawera Lake, Rotomahana, Lake Taupo.

Astelia cunninghamii, Hook. f.—Tarawera Lake.

Juncus maritimus, Lam.—Abundant amongst boiling springs, etc., on both sides of the Waikato, at Orakeikorako, and at Rotorua.

Leptocarpus simplex, A. Rich.—Rotorua.

Scirpus maritimus, L.—Rotoiti, Rotorua, Tarawera, Rotomahana, Orakeikorako, Lake Taupo.

Carex pumila, Thunb.—Rotorua.

Zoysia pungens, Willd.—Taupo plains, and about all the lakes.

Bromus arenarius, Lab.—Rotorua.

Poa australis, Br., var. *lævis*.—In all the low vallies from Te Ngae southwards, but nowhere found on the hills above 1,600 feet.

Zoysia pungens and *Poa lævis* are the only forms found over extensive areas; the propriety of considering the latter to be a littoral plant may possibly be questioned by those who are familiar with its distribution in the South Island only. In the North Island it occurs almost exclusively by the sea, or by tidal rivers, as at Port Waikato, except when under similar circumstances to those now under consideration, as at Cambridge in the Middle Waikato, from which locality it has been carried by the river to a recently formed island at Rangiriri, as I learn from a specimen given me by Captain F. W. Hutton. Mr. Buchanan informs me that in several instances in the South Island it distinctly marks the margins of ancient sea basins.

The examination of the southern and western parts of the district is necessary to the full consideration of this interesting subject.

It is worthy of remark that Rotokakahi and the Tikitapu Lake are the only lakes at which littoral plants were not collected. These are situate at an elevation of about 1,400 feet, or 300 feet higher than Lake Tarawera, and nearly 200 feet above Lake Taupo. This points to the greater age of the first-named lakes, and accounts for the absence of maritime plants on their shores.

The contrast between the arboreal vegetation of Rotokakahi and Rototarawera is most striking, and from the short distance that separates the two lakes is at once realized by the traveller. The most prominent trees on the banks of the former are terrestrial specimens of *Metrosideros robusta*, marked by small, compact, uniform, green-tinted foliage; on the latter, *M. tomentosa*, with spreading tortuous arms, and bold, grey, many-tinted foliage, changing with every breath of wind,—the one a plant specially characteristic of inland forests, the other equally characteristic of the northern cliffs and sea beaches.

SUMMARY.

For convenience of reference, I have prepared the following brief summary of the additions to our phyto-geographical knowledge comprised in this paper:—

Clematis colensoi, Hook. f.—Sparingly in earthquake fissures in the Waihorepa valley, the most northern locality known to me.

Montia fontana, L.—Attains its northern limit at Kaitiriria; altitude 1,500 feet.

Elatine americana, Arnott.—Exhibits an extension of its known range eastward at Maketu, and southward at Rotorua.

Pomaderris phylicifolia, Lodd.—In abundance between Whakarewarewa and Kaitiiiria; not observed further south.

Coriaria thymifolia, Humb.—Attains its northern limit at Opepe, where it is certainly perennial. Captain Gilbert Mair informs me that it has an outlying habitat at Matata, on the East Coast.

Carmichœlia juncea, Col., (identified in the absence of flowers) reaches its northern limit at Rotorua.

Haloragis, n.s.—Motukino.

Myriophyllum, n.s.—In habit much resembling *Crantzia lineata*; forms compact masses 2 to 3 inches in height in water from 1 to 5 feet deep; Rotokakahi; specimens imperfect.

Myriophyllum, n.s., habit of *M. integrifolia.*—Moist ground; Tikitapu Lake; specimens imperfect.

Metrosideros hypericifolia, A. Cunn.—Found on the summit of Tarawera mountain.

Hydrocotyle heteromeria, DC.—Rotokakahi; the most southern locality yet recorded for a plant which will probably prove to have a wide distribution although remarkably sparse.

? *Pozoa*, sp.—A minute plant, doubtfully referred to this genus in the absence of any trace of flower or fruit, was collected on the steep side of a deep ravine at Motukino.

Alseuosmia macrophylla, A. Cunn.—Crests of Ngongotaha and adjacent ranges, 2,300 feet, the most southern locality yet recorded.

Corokia buddleoides, A. Cunn.—Summit of Tarawera, the most southern habitat recorded; altitude, 3,600 feet.

Coprosma lucida, Forst.—Summit of Tarawera.

Olearia furfuracea, Hook. f.—Summit of Tarawera mountain, 3,600 feet.

Craspedia fimbriata, DC.—The most northern locality noted was at Kotukuroa Creek, but I believe the plant occurs at Maungarewa, twelve miles nearer Tauranga.

Cassinia vauvilliersii, Hook. f.—Attains its northern boundary at Motukino.

Raoulia monroi, Hook, f.—Summit of Tarawera; altitude, 3,600 feet, where it attains its northern limit; found also at Motukino, 1,500 feet. The first record of its discovery in the North Island, although specimens collected on the Kaimanawa mountains in 1870 by Dr. Hector are in the herbarium of the Colonial Museum.

R. hectori, Hook. f. (flowers not seen).—Attains its northern limit south of Oruanui, where it forms large patches on the plains; altitude, 1,600 feet.

Gnaphalium filicaule, Hook. f.—Northern boundary at Kotukuroa Creek, north of Rotorua.

Gaultheria fagifolia, Hook. f.—Motukino; not found elsewhere.

G. oppositifolia, Hook. f.—Attains its northern boundary at Kotukuroa creek, but cannot be compared in luxuriance with the splendid specimens at Rotokakahi and Lake Taupo; ascends to 3,200 feet on Tarawera mountain.

Cyathodes empetrifolia, Hook. f.—Attains its northern limit in a fissure in the Waihorepa valley, and on Tarawera mountain. In the valley the stems are diffuse, 2 to 6 feet long; on the mountain short and erect.

Dracophyllum strictum, Hook, f.—The common form in the district is var. *b.*, but the two forms pass insensibly into each other. *b.* occurs in the summit of Tarawera mountain, and reaches its northern limit at the Tamahere narrows, Middle Waikato; a most attractive plant.

D. longifolium, Br.—Attains its northern limit on the summit of Tarawera, altitude, 3,600 feet. Identified in the absence of flowers, but the habit of the plant can scarcely be mistaken.

D. subulatum, Hook. f.—The most characteristic plant of the Taupo district, attains its northern limit near the Kotukuroa Creek; summit of Tarawera, 3,600 feet.

Gentiana montana, Forst.—Attains the northern limit of the genus at Opepe.

Gratiola sexdentata, A. Cunn.—Ohinemutu, Rotomahana, etc. I have no note of a more southern habitat for this plant, although it probably occurs throughout the North Island.

Glossostigma elatinoides, Benth.—Common in the swamps and about the lakes, but has not been recorded from any locality further south.

Utricularia, n.s.—Amongst *Conferva*, Rotomahana; in appearance resembles *U. intermedia*, but the bladders are attached to the leaves.

Avicennia officinalis, L., attains its south-eastern limit in Tauranga harbour, northern part.

Alternanthera sessilis, Br.—Rotorua, the most southern locality yet recorded.

Plantago coronopus, L.—Native of Europe, naturalized on the beach at Tauranga; the first notice of its occurrence in the colony.

Muhlenbeckia axillaris, Hook. f.—Forms compact patches on the Taupo plains south of Oruanui, but is remarkably local, and attains here its northern boundary.

Chiloglottis traversii, F. von Muell. (*Caladenia bifolia*, Hook. f.)—Specimens long past flowering; occurs at Motukino, 1,500 feet, and amongst moss on the summit of Tarawera mountain, where it reaches its northern limit. Distinguished from all other New Zealand orchids by its glandular pubescence.

Thelymitra longifolia, Forst.—Summit of Tarawera mountain, 3,600 feet.

Sparganium simplex, Huds.—Rotoiti, Rotorua, Rotomahana, etc.

Astelia trinervia, Kirk.—Near the summit of Tarawera, 3,300 feet.

Schœnus axillaris, Br.—Ohinemutu, &c., the most southern locality yet recorded.

Eleocharis sphacelata, Br.—Rotorua, Rotomahana, etc.; the most southerly habitat yet recorded; Lyall's habitat of Bluff Island for this species is probably erroneous.

Isolepis aucklandica, Hook. f.—Attains its northern limit at about one mile east of Otumakokori; altitude, 1,500 feet.

Fimbristylis dichotoma, Vahl.—Attains its southern limit at Rotorua, in the modified temperature produced by the hot springs; with increased facilities for travel it will probably become established about all the hot springs in the Taupo country, as is already the case at Otumakokori.

Cladium articulatum, Br. — By Lake Taupo, the most southern locality observed; altitude, 1,200 feet.

C. junceum, Br.—Probably common throughout the North Island at least, but has not yet been recorded from any locality south of the lake district.

Lepidosperma concava, Br.—Attains its southern limit at Orakeikorako.

Sporobolus elongatus, Br.—Observed as far south as Lake Taupo.

Deschampsia cœspitosa, Palis.—Attains its northern limit at Rotorua.

Gleichenia dichotoma, Willd.—The accessory pinnæ are remarkably developed in some of the Rotomahana specimens; entirely confined to steaming, heated soil. This was first discovered at Rotomahana by Captain Gilbert Mair, who informed me that it grew sparingly about hot springs at Matata, on the East Coast; it occurs abundantly at Rotomahana and Otumakokori, in profusion about Orakeikorako, and again by some hot springs near Tapuaeharuru; also, I believe, sparingly about hot springs at Tokano, near the southern extremity of Lake Taupo; so that it has been found in scattered localities along the entire line of volcanic action, and is not so absolutely local as is commonly supposed.

Dicksonia antarctica, Br.—Common in forests between Maketu and Ngongotaha. Captain Mair informed me that he had seen specimens growing between Katikati and Ohinemuri, which doubtless mark its northern limit on the East Coast; and I learn from Mr. W. J. Palmer that a solitary specimen occurs about seven miles due west of Ngaruawahia, which will prove its northern boundary on the West Coast; where, however, its rarity is attested by the fact that the fern itself was quite unknown to Waikato natives who accompanied Mr. Palmer.

Asplenium colensoi, Moore, appears to find its northern limit at Motukino; altitude 1,500 feet.

Nephrodium molle, Desv.—Only found about the boiling wells and River Otumakokori. The Rotomahana habitat given in the "Handbook" is certainly an error, and I believe that Mr. Robert Mair's Whangarei plant must be referred to some other species.

Nephrodium thelypteris, Desv., var. *squamulosum*.—Rotomahana affords the most southern locality yet recorded.

N. unitum, Br.—Certainly the most abundant of the tropical ferns which owe their existence in New Zealand to the influence of hot springs; northern and eastern limit about hot springs at Maketu—on the authority of Captain Mair; Rotomahana, in immense profusion; Otumakokori, near Tapuaeharuru, and Waipihi, which is the most southern locality known to me, although it doubtless is found about the hot springs at the south of Lake Taupo.

Nephrolepis cordifolia, Baker.— Otumakokori, abundant. Captain Mair informed me that it had been found near Tapuaeharuru, but I failed to detect it in that locality.

Polypodium rupestre, Br.—Summit of Tarawera, 3,600 feet.

Schizœa dichotoma, Swartz.—Attains its southern limit at Orakeikorako, in the modified temperature of hot springs.

Lycopodium selago, L.—Attains its northern limit at Motukino; first recorded locality in the North Island.

L. densum, Lab.—Abundant near Kaitiriria; not observed further south.

L. cernuum, L.—Everywhere abundant about hot springs.

L. clavatum, L., var. *magellanicum*.—Attains its northern limit on the high land north of Rotorua.

L. volubile, Forst.—Ascends to 2,800 feet on Tarawera mountain.

Tmesipteris forsteri, Endl.—Summit of Tarawera mountain; epiphytic and terrestrial.

Psilotum triquetrum, Swartz.—Attains its southern limit at Orakeikorako.

Isoëtes kirkii, A. Braun.—Rotokakahi; the most southern habitat yet discovered.

ART. XLIII.—*On the Specific Characters of* Dicksonia antarctica, *Br.*, *and* Dicksonia lanata, *Col.* By T. KIRK, F.L.S.

[*Read before the Auckland Institute, 14th October, 1872.*]

THE characters presented by *Dicksonia antarctica* and *D. lanata* in these islands are so remarkably constant and so easily recognized, owing to the absence of intermediate forms, that it seems desirable to inquire if their union, under the name of *Dicksonia antarctica*, can be maintained. I must confess at the outset that it is with the greatest diffidence I venture to dissent from the opinion of so high an authority as the late Sir William Hooker, but after a careful examination of both forms in a recent condition, and in many localities, it appears to me that a student unacquainted with either would fail

to identify the form generally known to New Zealand botanists as "*lanata*" by the aid of the diagnosis of "*antarctica*" given in "Synopsis filicum," although the former is quoted as a synonym.

Dicksonia antarctica, the wekiponga of the Maoris, is a fine arborescent fern, in these islands attaining the height of from 10 to 20 feet or more, with the trunk clothed with a dense covering of fibrous, matted rootlets so that it is sometimes 18 inches in diameter (in Australia it attains the height of 40 ft., with a diameter of 4 ft.), presenting a peculiar, massive, and columnar appearance, by which it is at once recognized. Fronds spreading, lanceolate, 4 to 8 ft. in length, and from 8 to 18 inches in width; stipes extremely short, the dead fronds being persistent and completely shrouding the upper part of the stem, coriaceous, and of a peculiarly harsh, thin texture, green beneath; primary divisions 5 to 9 inches in length, narrowed into long points, segments. acutely toothed, oblong. Barren fronds similar to the fertile.

At Ohinemutu a small group of specimens of this form may be seen growing in an exposed rocky situation on the banks of the lake. Yet notwithstanding their depauperated condition the distinctive characters are as strongly marked as in the largest specimens on the adjacent hills. There is not the slightest approach to the appearance of *D. lanata* when growing under similar conditions.

In *D. lanata* the caudex is usually wanting, and is never more than from 4 to 5 ft. in height; it never produces matted rootlets, except as in all tree-ferns at the very base, so that the attached portions of the old stipes are visible from the root to the apex; fronds arched, ascending, 1 to 5 ft. in length, broadly lanceolate or elliptic, 1 to 2½ feet broad, abruptly acuminate; stipes at least half the length of the frond; lower primary divisions oblong-deltoid, upper oblong, abruptly acuminate, not narrowed into long points, very coriaceous; segments broadly oblong, obtusely toothed; the base of the stipe clothed with long jointed hairs, much more luxuriant than in *D. antarctica*; rachis glabrous or sparingly pubescent; sori larger and more prominent than in *D. antarctica*. Barren fronds, with the pinnæ deltoid; segments coriaceous, lobulate or pinnatifid, obtusely toothed, whitish below.

From the preceding brief statement it will, I think, be readily granted that the difference between the two forms is too great to allow of their being lumped together without at least some mention of their prominent characteristics, more especially as their distribution in these islands exhibits marked peculiarities.

D. antarctica is found from Tauranga to Otago, and is most abundant in the forests of the interior, ascending to about 3,000 feet.

D. lanata is found from Mongonui to Nelson, and does not occur at above 2,000 feet.

It is especially to be remarked that arborescent specimens of *D. lanata* become rare as the plant recedes from the north, until at Taupo, as was long since pointed out by Colenso (the discoverer of both species in the colony) it covers the ground like *Pteris*. At Whangarei, Kaipara, and other localities north of the Auckland Isthmus, stemless specimens are extremely rare,—arborescent specimens are abundant. *D. lanata* is also far more local within its area than *D. antarctica*.

D. lanata is endemic in these islands, while *D. antarctica* is found in East Australia, Tasmania, New Caledonia, and New Zealand.

Colenso states that the Maoris of the interior formerly used boards cut from the fibrous part of the stem of *D. antarctica* in the construction of their provision stores, the tough wiry fibres affording almost complete immunity from the attacks of rats.

ART. XLIV.—*Notice of a remarkable Arborescent Fern on Ngongotaha.* By T. KIRK, F.L.S.

[Read before the Auckland Institute, 14th October, 1872.]

AT the height of about 1,400 feet on Ngongotaha, a wooded peak on the south-west side of Rotorua, I met with a remarkable specimen of *Cyathea dealbata*, Swartz, the silver tree-fern of the settlers.

The specimen is between nine and ten feet in height, with the trunk somewhat inclined; at about eight feet from the ground it divides into two branches, each under eighteen inches in length; one of these is again divided, but the branches have not diverged, and are growing in such close contact as to resemble at first sight rather a single branch with a double crown, than two distinct branches. All the branches are crowned with fronds.

The trunk presents no marked feature, but the branches are much thickened and swollen, partly from being covered with a dense coat of hardened paleaceous scales; amongst these scales lateral crowns have become developed and given off fronds, varying in number from three to five on each crown, and from six to fifteen inches in length.

This singular specimen had evidently been recently scorched by fire, which had destroyed a portion of the old fronds; new fronds were developing in the greatest health and vigour.

From the condition of the branches, I am led to infer that they owe their origin to a division of the growing point arising from the attacks of insects, and that a continuance of the same cause has led to a development of the lateral crowns. This might possibly have been proved or disproved by a

dissection of the branches, but as the destruction of the specimen, which is probably unique, would have been involved the idea was not entertained.

The whole process is strictly analogous to that which takes place under similar circumstances in phænogamic plants, although the formation of lateral crowns in plants which do not produce buds cannot be satisfactorily explained at present.

A similar case is recorded as having occurred in a Javanese *Alsophila*, but I am not aware of any other instance having attracted notice.

Branched tree-ferns are so extremely rare that they usually attract the attention of settlers in the districts in which they occur, but on the range of hills of which Ngongotaha forms the extremity, I found three specimens of *Dicksonia squarrosa*, Swartz, each with a single branch, in symmetrical and healthy condition. At Great Omaha I discovered a single branched specimen of *Cyathea dealbata*, Swartz, the branch about six feet in length; another specimen occurs in the Hunua, and a third is said to grow on the Great Barrier Island. Colenso describes a remarkable specimen of this species, three-branched at five feet from the ground, each branch being four feet in length, growing at Owae.

I am not aware that any branched specimens of *C. medullaris* have been observed, but in the parish of Opaheki a remarkable specimen of *C. cunninghamii* is still growing; the main trunk is inclined to about eighteen inches from its base, when three erect branches are given off; the outer being respectively nine and ten feet long; the central one about six. All the branches are crowned with vigorous fronds.

Art. XLV.—*Notice of a New Species of* Senecio, (S. hectori).

By John Buchanan, of the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 28th August,* 1872.]

A branched woody shrub-tree, 6 to 12 feet high; stem 4 to 6 inches diameter; branches robust, erect.

Leaves sessile, 12 to 18 inches long, ovate-acuminate or ovate-lanceolate, tapering to both ends, $\frac{1}{10}$ of leaf at base pinnatisect, dentate with bristle points, membranous, upper surface scabrous, under surface thinly tomentose, white; veins distinct on both sides.

Corymbs lax, large, terminal; lower bracts foliaceous, upper numerous, linear, very narrow; peduncles and pedicels very narrow, slender, glandular-pubescent.

Involucre broad, campanulate, scales of one series, broadly linear, acute, tips brown, thick, with membranous border, glandular-pubescent.

Receptacle flat; alveola with scarious margins.

Heads $1\frac{1}{2}$ to 2 inches across; florets of the ray white, very narrow, $\frac{1}{2}$ inch long; anthers tailed; pappus of one equal series of rigid, scabrous, white hairs, slightly thickened at the tips.

Achene glabrous, narrow, linear, flattened and grooved.

This remarkable addition to the flora of New Zealand was collected by Dr. Hector on the Buller River, Nelson province, in January, 1872.

The magnificent floral display of this species, and others such as *Senecio glastifolius* with similar white rayed flowers, can only be seen to advantage in their natural humid habitats, and it is doubtful if any cultivation short of shelter under glass will be successful in rearing them in gardens.

Grows along the banks of the Buller River, and in rich bottom shrubberies between the River Mangles and the Inangahua; not observed in the lower gorge, nor near the sea. Also collected by Dr. Hector inland from Collingwood, and reported by Mr. W. T. L. Travers as occurring at Wangapeka and a few other localities in the Nelson province, where he collected specimens many years ago.

ART. XLVI.—*List of Plants found on Miramar Peninsula, Wellington Harbour.** By JOHN BUCHANAN.

[Read before the Wellington Philosophical Society, 25th September, 1872.]

THE flora of the Miramar Peninsula may be arranged under plants of the bush, plants of the open country, and plants of the swamp, the latter including those of the sea-side and those of the sand-hills.

The bush, which has no doubt at a very recent period covered the greater part of the hills, is now confined to a few gullies in the northern portion of the peninsula. Several of the following species are few in numbers, and none are large timber trees. No pines are present, they having been cut down for building purposes, as the stumps of totara piles may still be seen in what have been the defence works of Maupui Pa, and it is unlikely the timber was brought from a distance.

The following is a list of the trees and shrubs still existing:—

Clematis indivisa, *Willd.* Melicytus ramiflorus, *Forst.* Elæocarpus dentatus, *Vahl.* Melicope ternata, *Forst.* Melicope mantelli, *Buch.* Dysoxylum spectabile, *Hook. f.* Pennantia corymbosa, *Forst.* Corynocarpus lævigata, *Forst.* Carpodetus serratus, *Forst.* Metrosideros florida, *Sm.* Myrtus bullata, *Banks & Sol.* Myrtus ralphii, *Hook. f.* Fuchsia excorticata, *Linn. f.* Passiflora tetrandra, *Banks & Sol.* Panax

* Written to accompany paper by J. C. Crawford, F.G.S., on the Miramar Peninsula, see Art. LVII.

arboreum, *Forst.* Coprosma robusta, *Raoul.* Brachyglottis repanda, *Forst.* Myrsine urvillei, *DC.* Veronica arborea, *sp. nov.* Myoporum lætum, *Forst.* Knightia excelsa, *Br.* Piper excelsum, *Forst.* Rhipogonum scandens, *Forst.* Cordyline australis, *Hook. f.* Freycinetia banksii, *A. Cunn.*

The plants of the open country, popularly named scrub, are chiefly composed of species of shrubs, many of which usually grow up after the destruction of bush. With the exception of one shrub, *Carmichælia australis*, restricted to the northern half of the Peninsula, they are generally distributed over the whole area.

The following list includes the most prominent :—

Clematis colensoi, *Hook. fil.* Discaria toumatou, *Raoul.* Coriaria ruscifolia, *Linn.* Carmichælia australis, *Br.* Rubus australis, *Forst.* var. *a & g.* Leptospermum scoparium, *Forst.* L. ericoides, *A. Rich.* Metrosideros scandens, *Banks & Sol.* Aciphylla squarrosa, *Forst.* Coprosma divaricata, *A. Cunn.* Olearia virgata, *Hook. f.* O. solandri, *Hook. f.* Vittadinia australis, *A. Rich.* Cassinia leptophylla, *Br.* Gaultheria antipoda, *Forst.*, var. *a.* Muhlenbeckia adpressa, *Lab.* M. complexa, *Meisn.* Parsonsia albiflora, *Raoul.* Pimelea prostrata, *Vahl.* Phormium colensoi, *Hook f.* Libertia ixioides, *Sprengel.*

The following species usually form an undergrowth among scrub, or on rocks and banks :—

Ranunculus lappaceus, *Sm.* var. *multiscapus.* Nasturtium palustre, *DC.* Sisymbrium novæ-zealandiæ, *Hook. f.* Viola cunninghamii, *Hook. f.* Colobanthus subulatus, *Hook fil.* Hypericum gramineum, *Forst.* Geranium molle, *Linn.* Oxalis corniculata, *Linn.* Potentilla anserina, *Linn.* Acæna sanguisorbæ, *Vahl.* Haloragis alata, *Jacq.* Epilobium nummularifolium, *A. Cunn.* E. macropus, *Hook.* E. rotundifolium, *Forst.* E. pubens, *A. Rich.* Lagenophora forsteri, *DC.* Cotula australis, *Hook. fil.* Craspedia fimbriata, *DC.* Gnaphalium filicaule, *Hook. f.* Taraxacum dens-leonis, *Desf.* Wahlenbergia gracilis, *A. Rich.* Leucopogon frazeri, *A. Cunn.* Dichondra repens, *Forst.* Scleranthus biflorus, *Hook. fil.* Microtis porrifolia, *Spreng.* Thelymitra longifolia, *Forst.*

The greater portion of the peninsula is grass, with scattered scrub, the following indigenous species being still represented in the pasture :—

Echinopogon ovatus, *Palisot.* Dichelachne crinita, *Hook. f.* Agrostis parviflora, *Br.* A. æmula, *Br.* A. billardieri, *Br.* Apera arundinacea, *Hook. f.* Danthonia semiannularis, *Br.* Kœlaria cristata, *Pers.* Poa foliosa, Hook. *f.* P. anceps, *Forst.* P. australis, *Br.* var. *lævis.* Triticum scabrum, *Br.*

None of the large coarse tussock grasses are present, but on portions of the valley and enclosing hills where the surface is retentive of moisture a large growth of tussock-rushes prevails, formed chiefly of *Leptocarpus simplex* and *Juncus australis.*

The swamp, sand-dune, and sea-side botanical regions having here an esturine relation, may be grouped as one; spreading, as many of the species do, over the whole district, it would be difficult to separate them on the experience of this locality alone.

The *Phormium tenax,* which forms the principle feature in this group, is

noticeable from its great size, flower-stalks having been measured twelve feet high; *Arundo conspicua*, ten feet high; and the wide spread swamp plant, raupo (*Typha angustifolia*), ten feet high; the whole forming a close and safe refuge to many of the native water-fowl.

Ranunculus rivularis, *Banks & Sol.* Hymenanthera crassifolia, *Hook. f.* Colobanthus billardieri, *Fenzl.* Spergularia rubra, *Pers.* var. *marina.* Elatine americana, *Arnott.* Plagianthus divaricatus, *Forst.* Linum monogynum, *Forst.* Corynocarpus lævigata, *Forst.* Tillæa moschata. *DC.* Drosera binata, *Labill.* Myriophyllum elatinoides, *Gaud.* M. pedunculatum, *Hook. f.* Epilobium tetragonum, *Linn.* E. billardierianum, *Seringe.* E. pallidiflorum, *Sol.* Mesembryanthemum australe, *Sol.* Tetragonia expansa, *Murray.* Hydrocotyle novæ-zealandiæ, *DC.* H. asiatica, *Linn.* H. elongata, *A. Cunn.* Coprosma acerosa, *A. Cunn.* Galium umbrosum, *Forst.* Cotula coronopifolia, *Linn.* C. perpusilla, *Hook. f.* C. minuta, *Forst.* Raoulia australis, *Hook. f.* Gnaphalium keriense, *A. Cunn.* G. luteo-album, *Linn.* G. involucratum, *Forst.* Erechtites quadridentata, *DC.* Senecio lautus, *Forst.* Microseris Forsteri, *Hook. f.* Sonchus oleraceus, *Linn.* Lobelia anceps, *Thunb.* Selliera radicans, *Cavan.* Cyathodes acerosa, *Br.* Samolus littoralis, *Br.* Convolvulus sepium, *Linn.* C. soldanella, *Linn.*, Limosella aquatica, *var.* tenuifolia, *Linn.* Veronica parviflora, *Vahl.* Euphrasia cuneata, *Forst.* Chenopodium triandrum, *Forst.* Salicornia indica, *Willd.* Polygonum minus, *Huds.* var. *decipiens.* Pimelea arenaria. *A. Cunn.* Euphorbia glauca, *Forst.* Typha angustifolia, *Linn.* Lemna minor, *Linn.* Potamogeton natans, *Linn.* Phormium tenax, *Forst.* Juncus vaginatus. *Br.* J. australis, *Hook. f.* J. maritimus, *Lam.* J. bufonius, *Linn.* J. communis, *E. Meyer.* J. capillaceus, *Hook. f.* Luzula campestris, *DC.* Leptocarpus simplex, *A. Rich.* Gaimardia setacea, *Hook. f.* Cyperus ustulatus, *A. Rich.* Scirpus maritimus, *Linn.* S. triqueter, *Linn.* Eleocharis gracilis, *Br.* Isolepis prolifer, *Br.* I. riparia, *Br.* Desmoschœnus spiralis, *Hook. f.* Cladium junceum, *Br.* Lepidosperma tetragona, *Labill.* Uncinia australis, *Pers.* Carex teretiuscula, *Good.* C. virgata, *Sol.* C. ternaria, *Forst.* C. testacea, *Sol.* C. pumila, *Thunb.* C. forsteri, *Wahl.* C. dissita, *Sol.* Spinifex hirsutus, *Labill.* Arundo conspicua, *Forst.* Arundo ——, *sp. nov.* Festuca littoralis, *Br.* Azolla rubra, *Br.*

The ferns are few both in species and numbers, many having no doubt disappeared with the bush which gave them shelter:—

Cyathea dealbata, *Swartz.* C. medullaris, *Swartz.* Hymenophyllum tunbridgense, *Smith.* H. polyanthos, *Swartz.* Adiantum diaphanum, *Blume.* A. affine, *Willd.* Pteris aquilina, *Linn.*, var. *esculenta.* P. incisa, *Thunb.* Lomaria filiformis, *A. Cunn.* L. membranacea, *Colenso.* Lomaria procera, *Spreng.*, vars. L. banksii, *Hook. f.* Asplenium obtusatum, *Forst.*, var. *g. lucidum.* A. hookerianum, *Col.* A. bulbiferum, *Forst.* Aspidium richardi, *Hook.* Nephrodium hispidum, *Hook.* Polypodium serpens, *Forst.* P. billardieri, *Br.* P. pustulatum, *Forst.* P. pennigerum, *Forst.* Gymnogramme leptophylla, *Desv.* Lycopodium volubile, *Forst.*

Introduced species of plants are comparatively few, and have made little progress towards displacement of the indigenous species; this may be accounted for in some measure by the isolated situation, but mostly by the vigorous growth of the plants in possession; only where the scrub is burnt and nothing useful sown, as on the southern sea slopes, or on blown sand where there is only a sparse vegetation, can even the thistle find a holding ground.

In the following list many of the species are poorly represented, and many are confined to the sea shore, while none of them have attained the same extent here as in other parts of the province :—

Carduus lanceolatus, *Linn.* Helminthia echioides, *Gærtn.* (rare). Cerastium vulgatum, *Linn.* Sherardia arvensis, *Linn.* Anagallis arvensis, *Linn.* Euphorbia peplus, *Linn.* Erodium cicutarium, *Sm.* Stellaria media, *With.* Polycarpon tetraphyllum, *Linn.* (abundant on the sea-shore). Geranium molle, *Linn.* Fumaria officinalis, *Linn.* Apargia hispida, *Willd.* Leontodon taraxacum, *Linn.* Hypochæris radicata, *Linn.* (not common.) Sagina procumbens, *Linn.* Rumex viridis, *Sibth.* Rumex maritimus, *Linn.* Rumex acetosella, *Linn.* Lythrum hyssopifolia, *Linn.* Nasturtium officinale, *Br.* Plantago lanceolata, *Linn.* Centaurea solstitialis, *Linn.* (spreading on the sea-shore). Prunella vulgaris, *Linn.* Rosa canina, *Linn.* (not common). Cytisus scoparius (yellow broom), *DC.* (confined to one patch near Maupui Pa). Ulex europæus, *Linn.* (furze). This dangerous weed is limited at present to a small patch on the shore of Evans Bay, and another near the old Pilot Station.

Of useful plants as pasture, the following were collected :—

Melilotus officinalis, *Linn.* (spreading over blown sand, and acting as a binder by its deep rooting.) Medicago lupulina, *Linn.* Trifolium repens, *Linn.* Holcus lanatus, *Linn.* Lolium perenne, *Linn.* Festuca bromoides, *Linn.* Gastridium lendigerum, *Beauv.* Lagurus ovatus, *Linn.* Poa annua, *Linn.* P. pratense, *Linn.* Anthoxanthum odoratum, *Linn.* Dactylis glomerata, *Linn.* Bromus commutatus, *Schrad.* B. arvensis, *Linn.* B. mollis, *Linn.* Ammophila arundinacea, *Host.*

Some are probably omitted from want of flowering or fruiting specimens to determine the species.

ART. XLVII.—*On the Fertilization of the New Zealand Species of* Pterostylis. By THOS. F. CHEESEMAN.

(With Illustration.)

[*Read before the Auckland Institute, 14th October,* 1872.]

PERHAPS the most interesting study connected with the structural peculiarities of Orchids is that of the varying means by which, in the majority of the species, fertilization by insect agency is secured. The wonderful co-adaptation of all the parts of the flower to effect this end, the degree in which organs have become modified to uses widely different from their normal functions, and the general fertility of contrivance exhibited, can never fail to excite our admiration and surprise.

Although none of the New Zealand Orchideæ exhibit a mode of fertilization, founded on such complexity of structure and specialization of parts, as occurs in some of the tropical American and Asiatic genera ; and although probably none equal in this respect the British species of *Orchis* and *Ophrys*, yet several kinds present interesting and noteworthy peculiarities. These are

so strongly marked in *Pterostylis*, that I have ventured to draw up the following account of my observations on that genus. I have been the more induced to do this from the fact that Mr. Darwin's book "On the Fertilization of Orchids," which is deservedly considered to be the standard work on the subject, does not contain an account of a similar method of fertilization; nor is any species described, included in the sub-order Arethuseæ to which *Pterostylis* belongs.

The genus *Pterostylis* is represented in New Zealand by seven species. Of these, six (*P. banksii*, *P. graminea*, *P. micromega*, *P. foliata*, *P. trullifolia*, and *P. puberula*,) constitute a closely connected series of forms, and seem to present no differences of importance in their fertilization. The seventh species (*P. squamata*) belongs to another section of the genus, and (judging from descriptions) differs in several respects from the others. It is stated in the "Handbook" to have been discovered near Auckland by the late Dr. Sinclair, but I have not been fortunate enough to find it, nor has the plant been seen by any New Zealand botanist of late years. I shall now proceed to describe the mode of fertilization in *P. trullifolia*, the species on which my observations are the most complete. The accompanying illustration (Pl. XX.), containing magnified drawings of the most important parts of the flower, will perhaps cause my meaning to be more easily understood.

The upper sepal and petals connive and form a kind of hood, inclosing and arching over the column. The lateral sepals are placed in front of this hood, and being united for fully half their length, partially close the entrance to it. The column (see figs. C. and D., and *c.* in fig. B.,) is bent backwards at the base, so as to lie close to the upper sepal, with which for some distance it is united; it then becomes erect, and towards the summit is furnished with two broad membranous wings, each of which is extended downwards into a blunt lobe, and upwards into an erect horn-like appendage. The stigma (*s.* in Figs. C. and D.) is a bilobed prominence about the middle of the column. The anther (*a.*, Figs. C. and D.) is terminal, hinged on to the summit of the column, two-celled, the cells opening while the flower is still unexpanded. The pollinia (*p.*, Figs. D. and E.) are four in number, two in each cell, linear in shape. They lie loose in their cells, having no caudicles, and do not become attached to the rostellum. The rostellum (*r.*, in Fig. D.) is an erect, somewhat triangular projection, placed immediately below the anther. Its anterior surface is slightly concave, and consists of a thick mass of highly viscid matter, portions of which can easily be detached.

The lip, consisting of a linear, somewhat fleshy lamina, with a curious curved appendage at its base, is clawed on to the bottom of the lateral sepals by a delicate ribbon-like membrane. It is extremely sensitive, so that, although in its natural position it has its apex exserted between the free

points of the lateral sepals (see *l.*, Fig. B.), yet the slightest touch is sufficient to cause it to move quickly up to the column, when it occupies the position shown in Fig. C. On this movement of the lip the fertilization of the plant depends.

If we take a flower, and gently touch the lip, so as to cause it to perform the motion just described, and then examine the position of the parts, we see that each side of the flower is narrowed inwards in a curved line parallel to the position now occupied by the margins of the lip, so that the posterior part of the flower forms a chamber, to which the lip, resting against the wing-like appendages of the column, is a tolerably close fitting door.

Now let us suppose that an insect were to enter a freshly opened flower. The only entrance is between the tips of the lateral sepals, and here the apex of the lip is placed exactly where our visitor would probably alight. At first the weight of the insect would most likely counteract the natural tendency of the lip to move inwards, but as the insect crawls further into the flower, this would have less effect, until at length the irritability of the lip would enable it to overcome the resistance offered, and to spring back to the column. If no capture is made the lip soon regains its former position, but if the insect is imprisoned it remains firmly appressed to the column while its prey continues to move about. For the prisoner there is now only one mode of escape. This is by crawling up the column, passing over the stigma and viscid rostellum, and finally emerging from between the appendages of the column, directly in front of the anther. This passage, however, is so narrow and confined that it would not be possible for an insect to pass through without brushing against the rostellum, and detaching portions of its viscid surface. If the insect were now to touch the anther, and it is difficult to see how it can escape without doing so, one or more of the pollen-masses, lying loose in their cells, would become glued to the viscid matter on the insect's back, and consequently be withdrawn from the flower. To understand the mode of fertilization we have now only to suppose that the insect, with the pollinia attached to it, visits another flower, and is again imprisoned, when it is evident that in its efforts to escape it would pass over and in front of the stigma, which is sufficiently adhesive, when touched, to draw off a portion of a pollen-mass, or even a whole one, from the back of the insect.

After careful and repeated examinations of living plants, I adopted this view of the fertilization of *P. trullifolia* as the only one explaining the various facts I had collected; bnt, in order to satisfy myself that the lip really plays the important part I had supposed, I selected twelve flowers which were just expanding, and removed that organ from the whole of them. After a week or two, when they had closed and commenced to wither, I gathered them and examined their stigmas and pollinia. Not one flower was fertilized, and not a single pollen-mass had been removed.

On several occasions I have artificially inclosed small insects in the flower. Most escaped by crawling up the column and passing between the appendages, and some, but not all, carried pollen-masses away with them. It can hardly be expected, however, that insects selected at random would remove the pollinia with the same ease and certainty as the species to whose requirements the flower has no doubt been profoundly modified by natural selection, acting during long periods of time.

Although I have often watched the flowers I have never seen insects directly enter them. It occurred to me, however, that I should be more successful if I were to examine every plant noticed with the lip drawn back against the column. Acting on this idea I soon found three, each inclosing a small dipterous insect. Two of these had no traces of pollen on them, and the flowers were not fertilized. The third was dead, apparently not having been able to find the passage out of its prison. It had the remains of two pollinia attached to its back. The stigma of the flower was also plentifully covered with pollen, which had evidently been conveyed from another plant, for all four pollen-masses were intact and undisturbed in their cells.

The fact of this insect being unable to effect its escape led me to examine a considerable number of flowers which had commenced to wither, and in which the sepals and petals had closed together, with the view of ascertaining if this circumstance was of frequent occurrence. The results were important. Out of 110 specimens examined seventeen contained dead insects, and nine of these insects bore traces of having had pollen attached to them. Some had followed the passage between the wings of the column until they had reached the anther, and then becoming glued to the pollen-masses had not been able to drag them out of their cells, thus perishing on the threshold of their prison. Many of the flowers which did not inclose insects exhibited signs, besides the removal of the pollinia, of having been visited by them, from the presence of hairs, etc., adhering to the stigma and rostellum; and in one instance the antenna of some insect was found glued to the rostellum, proving that its owner had escaped by crawling through the passage in front of that organ.

All the insects proved to be Diptera, and all are probably referable to one species. I am not, however, entomologist enough to be able to indicate its name. What inducement there is to visit the plants I cannot conjecture, for even with the most careful examination I have not been able to detect the presence of any nectar, or nectar-secreting organs.

The comparatively large number of insects retained in the flowers examined appears at first sight to show a serious imperfection in the contrivances for insuring fertilization, as it is evident that it is a loss to the plant when its visitor cannot escape and carry away the pollinia. On a closer examination, however, it probably only proves how carefully the passage for the exit of the

insect has been modified to suit the relative size of the species by which the plant is fertilized, for if the passage had been of a size sufficient to allow the largest individuals to escape with ease the smaller ones would perhaps have been able to pass through without touching the rostellum. and consequently would not remove the pollinia.

It seldom happens that all the pollinia are removed. Out of 110 withered flowers twenty-eight had all the pollinia remaining in their anther cells, twenty-nine had lost one, thirty-four two, thirteen had three withdrawn, while only six had all four removed. Seventy-one of the flowers were fertilized, but it must not be forgotten that a large number of the unfertilized ones drop off before commencing to wither, so that the proportion fertilized is really much less than this. Probably not one quarter of the flowers ever produce capsules.

Of the other species of *Pterostylis*, *P. banksii*, *P. graminea*, and *P. puberula* are fertilized in exactly the same manner. There are, of course, slight differences in the size and arrangement of the parts of the flower, but it is hardly worth while describing these in detail here. In *P. puberula* nectar appears to be often present on the outside of the lateral sepals, near the point of their coalescence, serving, no doubt, to attract insects to the flower. *P. banksii* also has two minute papillæ at the base of the column, which may secrete nectar, but I have never observed any. The insect which fertilizes this species is nearly twice the size of that which performs the same office for *P. trullifolia*. I have seen an insect enter the flower of *P. graminea* and become entrapped by the lip. With *P. micromega* I am imperfectly acquainted, but believe the fertilization to be on the same plan. Of *P. foliata* I have only seen dried specimens, but as the structure of the flower is in the main the same as in *P. trullifolia* I have no doubt that it will prove to be fertilized in a similar way.

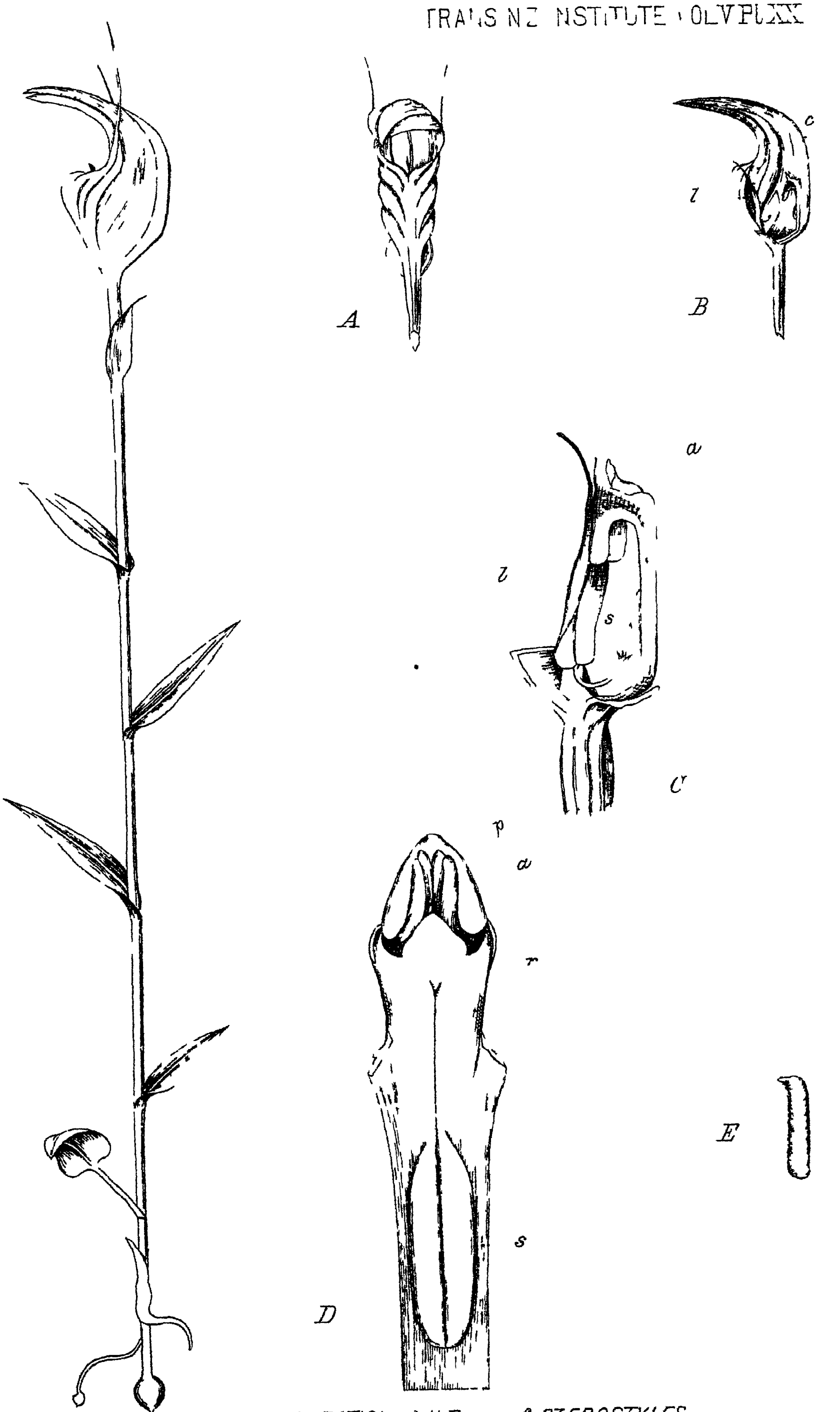
It seems hardly necessary to draw attention to the fact that the elaborate structure displayed in this genus is solely used to insure the pollen of one flower being placed on the stigma of a different one. It is not too much to say that the pollinia can never reach the stigma of the same flower, except, perhaps, by a combination of circumstances extremely unlikely to happen. As all our New Zealand species have solitary flowers, the cross effected is not only between different flowers but between different plants.

Description of Plate XX.

Pterostylis trullifolia, Hook. f. Natural size.

A. Front view of flower.

B. Lateral view of flower. The sepals and petals on one side removed to show the position of the column and lip.



FERTILIZATION of N.Z. sp. of PTEROSTYLES

C. View of column and lip, showing the position taken by the lip when touched.

D. Front view of the upper part of the column, with the appendages cut off, so as to show the rostellum, and pollinia loose in their anther-cells.

E. Single pollinium removed from the anther.

a., anther ; *c.*, column ; *l.*, lip ; *p.*, pollinia ; *r.*, rostellum ; *s.*, stigma.

A. and B. natural size ; C. D. and E. magnified.

ART. XLVIII.—*On the Growth of* Phormium tenax.

By the Hon. Col. HAULTAIN.

[*Read before the Auckland Institute, 24th June,* 1872.]

THE growth of the *Phormium* plant, the period of its decay, the increase of its off-shoots, and more particularly the rate at which the leaves are produced, and the time required to bring them to maturity, are questions of great importance to those interested in the manufacture of the fibre.

The attention of the Flax Commissioners, when making their inquiries last year, was directed to these points; the mode of growth, and its increase under cultivation, were ascertained with some approach to accuracy, and are stated in the pages of their report;* but as that report has not yet been generally circulated (though I am glad to say that it has just been reprinted with the latest information that can be obtained), and as I have procured specimens to illustrate what they have noted, I will repeat the substance of their observations.

The plant when full grown consists ordinarily of a rhizome or prostrate stem, from the under side of which numerous fibrous rootlets strike into the ground, and from the extreme end a number of leaves proceed in succession, decaying and falling off after arriving at maturity. At a certain period a flower stem shoots up from the apex, after which the whole of the leaves and their rhizome having completed their functions die away ; but every year various fresh side shoots have started from the main rhizome, forming separate fans with roots and leaves, receiving at first nourishment from the parent stem, and gradually becoming independent plants, producing further shoots, and dying away after perfecting flower and seed. In dry, hard ground the rhizome is but imperfectly developed, and amongst sand-hills it becomes a vertical stem several feet in length, seeking its nourishment at that depth where abundant moisture is to be found.

* App. to Journ. H. of R., 1871, G. No. 4.

Some few attempts have been made at cultivation, but the slowness of growth of transplanted sets, and the great expense, have not given capitalists much encouragement to form plantations on a large scale for the supply of the raw material. It was found that the average rate of multiplication of sets did not exceed six in three years, and even at the end of that period the plants were not sufficiently established to supply a succession of well-grown leaves for manufacture, whilst the first cost of planting was very expensive, and in the case of a field of twenty-five acres near Patea was as much as £18 per acre, exclusive of fencing and clearing the ground.

Seeds sown in the Botanic Gardens at Wellington in the month of November, 1870, were above ground in twenty days, but at the end of ten months the most vigorous plants were not more than a foot in length, and others sown in a nursery garden near Wanganui, in soil of the richest possible description, from two to four feet deep, and irrigated in hot weather, after a growth of sixteen months were only single fans of four or five leaves, averaging two feet long by three-quarters of an inch in width; and it was evident that they would require several years more to grow into a bush which would bear cutting for fibre; although seeds of only the best varieties of tihore were sown, the young seedlings did not show any marked resemblance to the parent plants, but were of all varieties of colour.

In a large flax field, where all sorts of varieties may be found, the plants growing in the same description of soil are much of one size; the luxuriance of growth depends not on the variety, but on the nature of the soil in which they have established themselves. To illustrate this I have here several fans of the rataroa, one of the best varieties of tihore, grown at St. John's College from sets that were procured by Bishop Selwyn some twenty-five years ago from the East Cape. You will observe how greatly they vary in size and luxuriance. The large fan, with leaves nine or ten feet long, is from a plant which grew in the lowest, wettest, and richest part of a drained gully. The other specimen grew on a poor clay hillock; and there is every gradation between the two, according as the soil was wet and good, or poor and dry; yet they are all the same variety, and I believe the fibre is equally good for manufacturing purposes from each—it is, at least, as strong, and can be stripped out in Maori fashion with the same facility.

The *Phormium* attains its greatest size by the banks of streams, where there is plenty of running water to nourish the roots. In very wet stagnant swamps it is never so good, but improves immediately the swamps are drained.

The information obtained by the Commissioners with respect to the growth of the leaves was not so exact, as sufficient time to make the necessary observations had not been afforded them. They, however, ascertained from a variety of testimony that if a flax plant were cut quite down, there would be

a fresh growth of from four to six leaves within a twelvemonth; and they found that there was no constant difference of strength and quantity of the fibre procured from the various leaves of the same plant; but they were not able to determine what was the normal rate of growth of leaves in uncut plants, nor when each leaf had arrived at maturity. The opinions of manufacturers varied very considerably on these points—some supposing that the leaf required several years to reach its full growth, at all events that it did not commence to decay until it had remained for a long time in a state fit for manufacture.

For the purpose of settling this question, in the month of May, 1871, thirteen months ago, I marked the young centre leaves just shooting up in a number of the plants at St. John's College, and found that by September, during the four winter months of the year, in every instance at least one fresh leaf had made its appearance and taken the others' place, and in November, two months afterwards, these had again been replaced by fresh leaves. I found a more rapid growth in the summer months, so that in the course of the year generally six, or at least five, fresh leaves had been produced in every instance. I have two of the fans that I marked in this manner. One leaf marked "May, 1871," was the centre leaf thirteen months ago, it is now the seventh, and has already begun to decay; and the other leaves were marked at intervals, giving an average of two months for the growth of each leaf.

In two other fans I cut all the leaves at the same height from the ground on the 5th April last, and now observe that only the three centre ones in each plant have made any further growth, showing that the others were fully developed and had reached their full size, and that this maturity has been attained within six months of the first appearance of each leaf.

As to the age of a plant, or of any portion of it at the time of flowering, I cannot speak positively, and I believe it varies very much. Many of the tihores flower very sparsely, and often fail to perfect seed.

In large *Phormium* fields in certain years (it is generally supposed every third) there is a profusion of flower stalks (in 1871 in the Wairau plains there was a perfect forest of them), and in other years comparatively few, but we must not conclude that each fan flowers at the end of three years. On one rhizome there are the cicatrices of more than fifty leaves, which at the rate of six per annum would make it eight years old, and on another which flowered the year before there are only twenty-five or twenty-six. It will require several years of close observation to determine this point, but I do not think it is one of any practical importance, as the decay of one fan does not seem to interfere with the growth of the remainder of the bush, which increases as it gets older, the rate depending of course on the soil and locality in which it is found. We have found that with transplanted sets the increase

has been on an average six-fold in three years. I have counted forty-four fans on one that has been seven or eight years planted, and over 200 are often found on well grown bushes in suitable localities. The fan that has flowered, as already stated, invariably dies down the following year, but I have never yet seen an uninjured one which has shown any signs of decay from old age *before* flowering.

I do not profess to have given you in these remarks very much that is new, but I thought that you would not object to a *résumé* of what has been ascertained on this subject, and I will finish my paper with the following general conclusions:—

That there is an annual growth of five or six leaves on each fan of all *Phormium* bushes growing in favourable positions, and that each leaf is mature and fully developed in six months from its first appearance.

That leaves more than thirteen or fourteen months old are generally so decayed as to be unfit for manufacture.

That the practice of mowing off all the leaves of each fan must injure, and will gradually destroy the whole plant.

That the growth of transplanted sets and of seedlings of the *Phormium* is so tedious, and the expense of planting so great, that the cultivation cannot be carried out with advantage so long as the fibre is prepared only for roping purposes.

That as manufacturers must therefore depend on the existing *Phormium* fields for the supply of the raw material it is to their interest to use every means in their power to preserve them from injury.

Art. XLIX.—*Notes on Plants collected near Invercargill.* By J. S. Webb.

[*Read before the Otago Institute, 29th October*, 1872.]

Having promised Mr. Kirk that when time permitted I would send him a contribution to his herbarium from this province, I availed myself of a few unoccupied hours, during a visit to Invercargill in January of last year, to attempt a fulfilment of the promise. As the plants were for comparison with those of other localities, I concluded that the results of a searching examination of a narrow area would be more useful than desultory gatherings. I therefore collected every plant I could secure from about a square mile of tussock ground, between the Puni creek and the Main East road, about a mile out of the town. The vegetation proved to be very poor, and what struck me as very remarkable included very few introduced plants, and those chiefly of three or four species. Even the universal white clover had not there made headway

against the native vegetation, although cattle have been constantly wandering over the place ever since the first settlement of the district. Across the area examined I found the line of the old high road still quite plainly traceable, but even here the native plants held their own. Except in the neighbourhood of this track the surface had only been broken in one place, where a ditch had been formed. On the clay ridges thrown up on either side of this, that bright looking fern *Pteris scaberula* had established itself plentifully, but this was the only native plant that appeared to have been introduced as a consequence of the disturbance of the ground. The subsoil of the area is a not very stiff clay, through which, at a depth of from two to about ten feet, the prevailing gravel of the district could be reached. The ground is disposed in two terraces, that nearest to the creek being only a few feet lower than the other. So far as I could determine, there was absolutely no difference in vegetation between the terraces. The prevailing feature was snow-grass in huge tussocks, around the roots of which, hidden under the over-arching grass, the majority of the smaller plants obtainable were clustered. The immediate banks of the creek I did not explore so carefully as the tussock ground. Mr. Kirk has obliged me with the following list of the plants gathered :—

NATIVE PLANTS.

Ranunculus sinclairii.
,, plebeius ?
Geranium microphyllum.
Acæna sanguisorbæ.
,, novæ-zealandiæ.
Haloragis micrantha.
Myrtus pedunculata.
Epilobium alsinoides.
,, pallidiflorum
Galium tenuicaule.
Olearia virgata, *var.*
Celmisia longifolia
Lagenophora forsteri.
,, petiolata.
Craspedia fimbriata.
Cassinia fulvida.
Gnaphalium filicaule.
,, luteo-album.
,, involucratum.
Microseris forsteri.
Taraxacum dens-leonis.
Wahlenbergia gracilis.
,, saxicola.
Gaultheria ———?
Plantago spathulata.
Scleranthus biflorus.
Prasophyllum colensoi.
Potamogeton polygonifolius.
Juncus effusus (communis of *Meyer*).
,, planifolius.
,, bufonius.
Luzula congesta ?
Carex virgata.
,, forsteri.
Eleocharis gracillima.
Hierochloe redolens.
Danthonia cunninghami.
,, raoulii.
Deschampsia cæspitosa.
Trisetum antarcticum.
Poa breviglumis
Pteris scaberula.
Lomaria procera.
,, alpina.
Campylopus appressifolius.
Polytrichum commune.

INTRODUCED PLANTS.

Cerastium glomeratum.
Trifolium minus.
Prunella vulgaris.
Rumex acetosella.
Aira caryophyllea.
Holcus lanatus.

Mr. Kirk calls attention to the fact that of these plants the following are not mentioned either by Dr. Lindsay or Mr. Buchanan as occurring in this province, viz. :—

Haloragis micrantha.—This I found growing around the tussocks of snow-grass, and generally almost hidden by them.

Eleocharis gracillima.—This species has recently been distinguished by Dr. Hooker from *E. gracilis*, or rather has been acknowledged as being a distinct plant, and not a mere variety of the latter. It is a small rush-like plant. The specimen I retained has unfortunately been lost.

Acæna novæ-zealandiæ, Kirk.—This species has been determined by Mr. Kirk since the publication of Mr. Buchanan's lists of Otago plants. It is defined in Mr. Kirk's "Descriptions of New Plants," a paper read before the Auckland Institute two years ago (*Trans.* N.Z. Inst., Vol. III. p. 177).

Plantago spathulata.—Dr. Haast found this plant on terraces, and in the river bed in the Kowai valley. So far as I can recollect it is common where I found it, but I do not remember to have met with it elsewhere in Otago.

Potamogeton polygonifolius.—This plant is mentioned by Mr. Kirk in his "Notes on certain New Zealand Plants, not included in the 'Handbook of the New Zealand Flora'," (*Trans.* N.Z. Inst., Vol. III. p. 163). He remarks that though it is abundant in Europe, he is not aware of its existence elsewhere, except in New Zealand. Since it has now been reported from each extremity of the islands, it will probably be found to be universally distributed.

On the subject of the paucity of introduced plants, Mr. Kirk says, "Your notes on the ability of native plants to hold their ground under certain conditions against introduced kinds, agree in the main with my own observations made on the pumiceous soils in the centre of this (the North) Island." In connection with this subject, Mr. Kirk in a former letter directed my attention to some remarks by Mr. Travers, in his lecture on "Changes effected in the Natural Features of a New Country by the Introduction of Civilized Races" (*Trans.* N. Z. Inst., Vol. II., p. 312). Generalizing too hastily, I think, from a certain number of facts, striking in themselves, but not numerous enough nor observed under sufficiently varied circumstances to warrant his conclusion, Mr. Travers says, "such in effect is the activity with which introduced plants are doing their work, that I believe if every human being were at once removed from the islands for even a limited number of years, looking at the matter from a geological point of view, the introduced would succeed in displacing the indigenous fauna and flora." Judging from the state of things which exists in the area from which this collection of plants is derived, an area typical of very considerable districts in this part of New Zealand, we may well doubt whether the indigenous vegetation would not in most cases be found able to hold its own against the strongest intruders from foreign climes, unless the latter should be favoured by fostering circumstances, such as accompany the agricultural occupation of the soil by a civilized race. It is at least fifteen years since the cattle of European settlers first began to wander amongst the tussocks amidst which I gathered these specimens of plants. The old road now abandoned, to which I have alluded, was in use for years, yet the most

robust and tenacious of our introduced plants have not established themselves there. The few individuals which we find, appear there as intruders which do not flourish, but exist as it were by sufferance. They would probably die out altogether were it not that neighbouring cultivations serve as centres of propagation. As a matter of fact, the high road alone divides the area on which I collected from another which has for a long time been under cultivation and sown with English grasses, and even in the very midst of the former there existed at the time a paddock which had been twice ploughed, and was then under a crop of oats.

ART. L.—*On the Botany and Conchology of Great Omaha.*

By T. KIRK, F.L.S.

[*Read before the Auckland Institute, 23rd September,* 1872.]

THE harbour of Great Omaha is about forty-five miles north of Auckland, lying nearly midway between Mahurangi and Pakiri. For the purposes of this paper the district may roughly be sketched as extending from the Matakana Falls to Little Omaha, the latter situate about eight miles from Point Rodney.

The district is bounded on the west by the hills known as the Omaha or Pakiri ranges, which attain their greatest altitude, 1,380 feet, at Mount Hamilton, and are chiefly composed of sandstones overlying palæozoic slates, the latter often in a decomposed condition where exposed.

An outlying range of no great altitude, extending from Mount Hamilton to the head of the Matakana River, may be considered the southern boundary, while the coast line from thence to Takatau Point, and inwards from the mouth of the harbour to Little Omaha, will form its eastern side.

Dioritic rocks occur at the entrance to the harbour and other places. Fossil shells of several species are found at Kohuroa and Little Omaha; amongst those collected in the latter locality is an immense *Ostrea* which exhibits singular and varied forms. The southern boundary is marked by a sharp conical peak of diorite which at once attracts the notice of the traveller from the contrast it offers to the rounded summits of the adjacent hills. From the base of the range, and extending to the inner waters of the harbour, is a considerable extent of flat land, much of it swampy and intersected by numerous small streams. The inner waters are separated from the ocean by Whangatau, a peninsula of blown sand with a magnificent beach three miles in length and half a mile in width at low water. The entrance to the harbour is narrowed by a conical rock, which is exposed at half tide, but

coasting craft can enter on either side, although great care is requisite. Whangatau is becoming fixed by vegetation in its widest part, but is continually varying in its outline and in the depth of water covering that portion comprised between tide marks. From the mouth of the harbour to Omaha Cove the coast is rocky, and in some places precipitous. At a low elevation there is a considerable extent of fern land.

The larger portion of the hill is clothed with dense forest, the kauri and the tarairi (*Nesodaphne tarairi*) often forming large groves. The tawai (*Fagus fusca*) is also a social tree, and attains a large size, while it does not favour a luxuriant undergrowth of shrubs. One or two ranges are covered almost exclusively with pohutukawa of the straight symmetrical habit of growth known as "inland pohutukawa," which contrasts forcibly with the huge distorted specimens growing on the margin of the sea. Fine specimens of tanekaha (*Phyllocladus trichomanoides*) are abundant, and the toa-toa (*P. glauca*) occurs in one or two localities, while the kawaka (*Libocedrus doniana*) is comparatively rare. The puriri (*Vitex littoralis*) is abundant. *Pittosporum crassifolium* and *P. eugenioides* form large specimens, and on the summit of Mount Hamilton *P. kirkii* is epiphytic on the rata and other trees. The tawa (*Nesodaphne tawa*) is found in large quantities mixed with toro (*Persoonia toro*), rimu (*Dacrydium cupressinum*), kahikatea (*Podocarpus dacrydioides*), hinau (*Elæocarpus dentatus*) and other well known trees.

The various arms of the harbour are fringed with a growth of mangroves (*Avicennia officinalis*) usually of great luxuriance, which is, however, dying off in many places from being frequently cropped by cattle. Many of the creeks have their rise far back in the ranges, and in some instances form a series of fine cascades several hundred feet in height, often decorated with tree ferns, and more than usually picturesque in effect. In some places they flow amongst fallen masses of sandstone covered with *Hypnum albicans* and other mosses not commonly met with, perchance between steep banks clothed with *Elatostemma rugosum* in vast abundance, or yet again between rocky wooded slopes often covered with masses of *Corysanthes*; nearly all the species of this charming genus occur in the district. The stream called by the settlers the Pakiri Creek has its stony bed above tide limits covered with a dense growth of *Nertera cunninghamii* to an extent rarely to be seen elsewhere.

Many small Orchids, besides the various species of *Nematoceras*, are found in the district. *Thelymitra pulchella* and *T. imberbis* are abundant. The rare *Adenochilus gracilis* and *Chiloglottis cornuta* attain their northern limit so far as at present ascertained.

Whangatau beach affords a fine habitat for littoral plants. Most of the New Zealand species which occur in littoral situations are found here; amongst them *Atriplex billardieri* attains its southern limit, and is plentiful in

certain seasons. In 1863 it was growing near the mouth of the harbour in a peculiar manner, the blown sand gathering about the plant formed little hummocks through which the branches pushed their way to the surface, so that at a short distance the low white mounds appeared dotted over with green rosettes. A change in the outline of the beach in 1864 destroyed the plant in this part, and I have only seen it at the further end of the beach during recent visits. About the middle of the beach, but far back from high water-mark, is a clump of noble specimens of the pohutukawa and the tarata (*Pittosporum crassifolium*) which doubtless mark the site of the old margin. A peculiar variety of *Carex raoulii* has arched and procumbent culms sometimes more than six feet in length, and accompanies a slender sub-erect form of *Pratia angulata.*

The preceding sketch of the chief physical characteristics of the district, and of the more prominent features of its vegetation, although very far indeed from being complete, is yet sufficient to show that the district is well adapted to support a large variety of molluscous life, and such is found to be the case. The enumeration at the close of this paper is not offered as a complete account of the shells to be found within its boundaries, but is the result of a cursory examination made nine or ten years ago, supplemented by a few species collected during recent visits, and especially by additions made by Mr. Charles Matthews, who is well acquainted with the plants and shells of the district, and to whom I take this opportunity of acknowledging my indebtedness for many rare specimens and much valuable information relative to habitats, etc.

The beach at Whangatau is exposed to the force of north-east gales, after which high water-mark is fringed with large specimens of *Turbo cookii*, *Pectunculus laticostatus*, *Struthiolaria papulosa*, *Cassis pyrum*, *Pecten laticostatus*, with more rarely the fine *Triton australis* and others. *Spirula peronii* is washed or rather blown amongst the sand-hills in countless thousands, whilst the beautiful *Janthina exigua*, and numbers of smaller shells, mark the extreme limits of the waves. Still more rarely *Imperator heliotropium* and the large *Janthina communis* may be collected. *Mactra discors* and *M. ventricosa* are not uncommon, and may be procured by digging beyond low water-mark. In the calmest weather, *Mesodesma cuneata* may be picked up between tide marks, and the common long pipi, *M. chemnitzii*, below low water-mark. *Pecten laticostatus* formerly occurred on a shoal accessible at neap tides, but the site is now covered by deep water, and the shell is found only after gales. The pretty *P. zealandicus* is frequently thrown on the beach, often associated with another interesting shell, *Scalaria zelebori.* *Solenomya australis*, the representative of the European razor-shells, with its periostraca produced beyond the margin of the shell, is often thrown up, but I never obtained

living specimens. *Ancillaria australis* is exposed at extreme low water-mark during neap tides. The rozy *Psammobia lineolata* is common, and may be easily collected in fine condition. In short, the Whangatau beach is one of the most productive localities known to me for marine shells. Eighty species may sometimes be picked up in a morning's walk.

In the harbour, which with the exception of the deeper channels is laid bare at low water, the mud-oyster is plentiful amongst the mangroves, associated with *Cerithium bicarinatum*, *Amphibola avellana*, *Buccinum costatum*, *Nerita nigra*, and *Turbo smaragdus*; the opercula of the last are used in Auckland for the manufacture of cheap jewellery, but are of little value.

Usually imbedded in the mud, with its point downwards, and accessible without much difficulty at low water, *Pinna zealandica* occurs in some qaantity, and near it *Turbo cookii*, *T. granosus*, and *Voluta pacifica*; the long pipi is also found sparingly in the same habitat.

The common pipi (*Venus stutchburyi*) is most abundant, and forms a large portion of the food of the few natives still living on the shores of the harbour; its dead valves have raised a huge bank many feet above low water-mark. *Myodora striata*, *Tellina deltoidea*, and *T. albinella*, with many other shells, occur in the same locality.

The rocks between tide marks afford favourable habitats for many species; *Littorina diemensis* and *Purpura rugosa* are usually sprinkled over their surface, as if sown broad-cast; *Littorina cincta* is comparatively rare. The rock oyster and limpets of various species abound, but the species of the latter rarely intermingle. *Siphonaria australis* is common in two or three localities, but local; the singular *Lottia fragilis*, which resembles a fragment of greenish membrane adhering to the rock, is found at Matakana and Little Omaha, but is far from common. *L. pileopsis* is also found near Little Omaha, with *Purpura haustrum*, *P. textiliosa*, and *P. succincta*.

On the sea-weeds may be seen *Bulla novæ-zealandiæ*, *Trochus margaritiferus*, and other molluscs, which live almost entirely on marine vegetation. *Triton spengleri* is chiefly found amongst *Zostera*, but is local. *Haliotis iris* may be observed from projecting rocks, as it moves along the sea-bottom, presenting a somewhat attractive appearance.

The forests afford shelter to a goodly sprinkling of land shells, chiefly *Helices*, many of which are minute, and have not yet been identified. *Helix zealandiæ* is not unfrequent on the nikau. *H. dunniæ*, the largest species inhabiting the district, frequents fallen timber. *H. radiaria* is common amongst moss on tree trunks; other species are found under loose bark, stones, or amongst climbing plants, and are far more common than is generally supposed.

The pretty native *Physa* occurs on weeds in fresh-water streams; an

undescribed *Paludinella* is common in similar habitats, with a spined *Melania*. *Melanopsis zealandiæ* is confined to rocky streams, where it is abundant, the upper whorls being usually much eroded. The fresh-water limpets, *Latia lateralis* and *L. neritoides* are plentiful. the latter often occurring in brackish water. Fluviatile bivalves are confined to two species, the large fresh-water mussel, *Unio menziesii*, and *Cyclas novæ-zealandiæ*; the latter appears to be extremely rare, although it is so easily overlooked that it may possibly be less rare than it seems.

In the swamps shells appear to be remarkably rare, the most noteworthy being *Vitrina zealandiæ*, which is extremely local, and apparently confined to clumps of *Astelia grandis*. In brackish swamps, *Ophicardelus australis* and *Melampus zealandiæ* take the place of the *Conovuli* of Europe.

In the upper part of the harbour, several large mounds of dead shells bear testimony of the value to the natives of molluscous animals as food; similar deposits are also common on the ranges near to the sea, where they are more scattered. All kinds except the most minute were eaten by them, and it seems clear that their efforts have resulted in the partial extirpation of at least one species, *Mesodesma chemnitzii*, which occurs in their middens and on the hills in immense quantity, and of large size; it is now comparatively rare and usually below the average size, and does not occur in anything like sufficient abundance to furnish such a supply of food as formerly. A detailed examination of the old mounds of dead shells might possibly show ground for similar conclusions with regard to other species. The ear-shell was used by the Maoris in the manufacture of fish-hooks, and for inlaying their rude carvings.

The only molluscs of economic value to the settler, so far as known to me, are the rock oyster, well known as affording a delicious article of food and the best of shell lime. The common pipi and the long pipi are most nutritious, and are often exposed in the Auckland market for food. Rats are as fond as the Maoris of the fresh-water mussel, *Unio menziesii*, and piles of shells emptied by them may frequently be seen on the banks of streams, but the settlers do not regard it with favour as an article of food. I have seen *Turbo cookii*, *Voluta pacifica*, and the ear-shell used as food by bushmen, but feel bound to say their appearance was not appetizing. The large ear-shell, *Haliotis iris*, is exported to England, where it is used for inlaying. The small shells of *Ancillaria australis*, and the opercula of *Trochus smaragdus* are used in the manufacture of ear-drops, studs, and brooches, by the Auckland jewellers.

TROPHIODA.

Teredo *sp.* In pohutukawa, &c.
,, *sp.* In dead stems of *Avicennia*.
Pholas similis, *Gray*. Dead valves only.
,, tridens, *Gray*. Ditto.
Panopæa australis, *Sow*.

Solenomya australis, *Lam*.
Corbula zealandica, *Quoy* & *Gaim*.
Mactra ventricosa, *Lam*.
,, cuneata, *Lam*.
,, discors, *Gray*.

TROPHIODA—*continued.*

Myodora striata. *Q.* & *G.*
Mesodesma cuneata, *Deshayes.*
,, chemnitzii, *Deshayes.*
Saxicava australis, *Lam.* Smaller than S. rugosa, *Lam.*, but presenting no other appreciable points of difference.
Psammobia stangeri, *Gray.*
,, lineolata, *Gray.*
,, nitida, *Gray.*
Tellina albinella, *Lam.*
,, deltoidalis, *Lam.*
Lucina divaricata, *Lam.*
,, zeylanica, *Gray.*
Cyclas zealandica, *Gray.*
Crenella impacta, *Heim.*
Venus spissa, *Q. & G.*
,, yatei, *Gray.*
,, stutchburyi, *Gray.*
,, costata, *Q. & G.*
,, corrugata, *Gmel.*
,, intermedia, *Quoy.*
Cardium pulchellum, *Gray.*
Tapes, *sp.*
Dosinia anus, *Philippi.*
,, subrosea, *Gray.*
Venericardia australis, *Q. & G.*
Arca, *sp.*
Pectunculus laticostatus, *Q & G.*
,, striatulum, *Lam.*
Nucula zealandica, *Gray.*
Unio menziesii, *Gray.*
Lithodomus truncatus, *Gray.*
Modiola australis, *Gray.*
Mytilus canaliculatus, *Mart.*
,, polyodontus, *Q. & G.*
,, ater, *Dunk.*
Pinna zealandica, *Gray.*
Lima, *sp.*
Pecten zealandica, *Gray.*
,, *sp.*
,, laticostatus, *Gmel.*
Anomia, *sp.*
Ostrea mordax, *Gould.* Rock oyster.
,, *sp.*
,, *sp.* Mud oyster.

BRACHIOPODA.

Terebratula sanguinea, *Lam.*
,, zealandica, *Des.*
Waldheimia, *sp.*
Magas cumingi, *Davidson.*

GASTEROPODA.

Chiton longicymba, *Q. & G.*
,, quoyii, *Desh.*
,, pellis-serpentis *Q. & G.*
,, *sp.*
Acanthocetes hookeri, *Gray.*
Patella radians, *Gmel.*
,, stellifera, *Gmel.*
,, inconspicua, *Gray.*
,, *sp.*
Lottia pileopsis, *Q. & G.*
,, fragilis *Q. & G.*
Siphonaria zealandica, *Q & G.*
,, australis. *Q. & G.*
Parmophorus australis, *Lamarck.* Dead shells only.
Emarginula, *sp.*
Fissurella, *sp.*
Crepidula costata, *Desh.*
,, contorta, *Quoy.*
Trochita tenuis, *Gray.*
Calyptræa dilatata, *Sow.*
,, *sp.*
Haliotis australis, *Mont.*
,, iris, *Gml.*
,, virginea, *Chem.*
Vermetus roseus, Q. & G. On dead shells.
,, vermiferus, Q & G.
Siliquaria, *sp.*
Aplustrum, *sp.*
Bulla quoyii, *Gray.*
,, australis, *Gray.*
,, nova-zealandica, *Gray.*
Limax bitentaculatus, *Quoy.*
,, agrestis, *L.* Naturalized.
Vitrina zealandica.
Helix dunniæ.
,, brownii.
,, dimorpha.
,, hypopolia.
,, hystrix.
,, zealandiæ.
radiaria.
coma.
subrugata.
vitrea.
compressivoluta.
igniflua.
greenwoodii.
Megalostoma zeylanica.
Physa novæ-zealandiæ.
Latia lateralis.
,, neritoides.
Melania zeylanica.
Melampus zealandiæ.
Paludinella, *sp.*
Ophicardelus australis.
Assiminea australis.
Amphibola avellana, *Gray.*
Nerita atrata, *Chem.*
Natica zealandica, *Quoy.*
Janthina exigua, *Lam.*
,, fragilis, *Bon.*
Rissoa, *sp.*
Scalaria australis, *Lam.*
,, zelebori, Q. & G.
Rotella lineolata, *Desh.*
Imperator heliotropium.
,, cookii, *Gmel.*
Turbo granosus, *Mont.*
,, smaragdus, *Lam.*

GASTEROPODA—*continued.*

Trochus margaritiferus.
Polydonta elegans, *Gray.*
,, *sp.*
Zizyphinus cunninghamii, *Gray.*
,, tigris.
Elenchus iris.
Monodonta lineolata.
Littorina diemensis, *Quoy.*
,, cincta, *Q. & G.*
,, *sp.*
Turritella rosea, *Quoy.*
Cerithium bicarinatum, *Gray.*
,, australe, *Gray.*
Fusus zealandicus, *Q. & G.*
,, nodosus, *Mont.*
,, dilatatus, *Q. & G.*
,, triton.
Pleurotoma rosea, *Sow.*
,, novæ-zealandiæ, *Reeve.*
Murex zealandicus.
,, nova-zealandica, *Gray.*
Ranella argus, *Lam.*
,, leucostoma, *Lam.*
Triton australis, *Lam.*
,, spengleri, *Chem.*
Triton, *sp.*
Struthiolaria vermes, *Mont.*
,, nodulosa, *Lam.*
,, papillosa, *Desh.*
Strombus troglodytes, *Lam.* A dead shell only, doubtless introduced by accident.
Cassis pyrum, *Lam.*
,, *sp.*
Ricinula, *sp.*
Purpura rugosa, *Q. & G.*
,, scobina, *Q.* & *G.*
,, haustum, *Lam.*
,, succincta, *Lam.*
,, textiliosa, *Lam.*
Dolium variegatum, *Lam.*, fragments only.
Buccinum turgidum, *Gray.*
,, melo.
,, lineolata, *Q. & G.*
,, maculosum, *Mart.*
,, costatum, *Q. & G.*
Ancillaria australis, *Sow.*
Voluta pacifica.
,, fusus.

CEPHALOPODA.

Spirula peronii.

IV.—CHEMISTRY.

Art. LI.—*On the Mode of Producing Auriferous Alloys by Wet Processes.* By W. Skey, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 23rd October,* 1872.]

In former papers read before this Society* I showed that metallic sulphides generally reduced gold from both acid and alkaline solutions; that silver as nitrate was reduced by galena and sulphide of copper, but not by iron pyrites, while its ammoniated solutions were unaffected by any of the sulphides experimented with; and from a consideration of these results I suggested that most of our native deposits of noble metals have been formed by the agency of metallic sulphides, and not by that of organic matter as has hitherto been generally supposed.

The question which naturally presented itself to me at the time as to the capability of processes of this nature producing alloys of such metals (as found in nature) was tacitly left over for consideration until the behaviour of these sulphides with metallic solutions should be more fully examined.

In pursuit of this question as to the possibility of obtaining mixed metallic deposits or alloys by the agency of metallic sulphides I have from time to time, as opportunity offered, studied the behaviour of different sulphides when in contact with various salts of gold and silver, and the principal results thus obtained I now beg to state.

1. That solutions of chloride of silver in alkaline chlorides, rendered alkaline by addition of potash, soda, or lime, are readily decomposed by common iron pyrites.

2. That this effect is not produced if such solution of silver is either acid or neutral.

3. That when chloride of gold is added to an alkaline argentiferous solution of this nature, such mixed solution is capable of depositing the metals contained in it in the form of coherent alloys upon metallic sulphides generally when presented to them.

4. That these alloys can also be formed from such solutions by voltaic action.

As will be seen these results show that, by allowing an alkaline solution of gold and silver contact with iron pyrites (a mineral of most common

* See *Trans.* N.Z. Inst., Vol. III., Arts. XL. and XLI.

occurrence in our reefs), we obtain that mixed deposit or alloy we are seeking to produce.

The only condition which appears to me from the results of numerous experiments necessary in regard to such metallic solutions is that they should be not only alkaline, but alkaline from presence of a fixed alkali or alkaline earth, and it will be remembered, perhaps, in connection with this circumstance, that this alkaline condition is one which I have recently shown* to be that of our silicates generally, whether simple or compound, with the exception of silicate of alumina and other corresponding silicates of the sesqui oxides, while quartz itself, whether free or in combination, is either quite neutral or of such very feeble acidic powers as regards intensity that when united, even in very greatly disproportionate quantity, with alkalies or alkaline earth the resulting compound gives an alkaline reaction.

If such then are the conditions (alkalinity or neutrality) of our surface rocks generally, it is clear that the condition of the water permeating them at some distance from the surface would be alkaline, the intensity of which would be largely increased were the retaining rock subjected to those hydrochemical influences popularly supposed to have operated for the deposition of their older vein matters and their metallic contents.

The fact that many mine waters are acid does not affect the truth of the conclusion thus drawn as to the general alkaline condition of the waters charging our rocks, since this acidity is, as is well known, brought about by the contact of air with pyritous matters, metallic sulphates thus being formed which communicate an acid reaction to water dissolving them. This is a mere surface affair as it were, and is besides in its manner of production entirely distinct from, if not antagonistic to that by which gold has been deposited in the pyritous portions, for a slight examination of these shows that the gold present in them has been deposited there before they were oxidized by atmospheric agency.

Alkalinity being then certainly the general condition of our waters permeating rocks, closed, or partially so, against the atmosphere, and this condition of liquids appearing essential for the production of alloys by humid methods, as shown here, it does seem highly probable that our native alloys of gold and silver have been deposited from *alkaline* solutions, and by such agents as I have suggested, viz., the metallic sulphides.

I will only add, in reference to the mode in which our deposits of native gold have been formed, that while the number of substances capable of precipitating this metal from solution is many, the number of those at all likely to have been actually concerned in the production of these deposits is very small indeed. As far as at present appears, the substances capable of reducing

* *Trans.* N.Z. Inst., Vol. IV., Art. LVI.

gold, and likely to occur in the interior parts of our rocks, are ferrous sulphate of iron, organic matter, and metallic sulphides. These also reduce silver from certain of its solutions, but, as already noted, the difficulty is in finding a substance which will reduce these two metals simultaneously in coherent forms, and from such kinds of solutions as generally permeate our rocks. With this double duty to perform, and limited in this manner as regards nature of solvent, I cannot avoid thinking that but one of these reducing agents, the metallic sulphides, will be found equal to the occasion. The ferrous sulphate is thrown out at once from this service on account of its insolubility in such a menstruum, while organic matter appears to have a decided tendency to scatter the gold it reduces (see Art. LII), nor have we, as far as I am aware, produced any true alloy of gold and silver by their use.

I would not intend to convey the idea that such a mixed deposition is impossible, but only that, from what we at present know of this subject, the production of such an alloy by these means appears a very difficult undertaking. However, this particular question is, I understand, now being dealt with by Mr. Daintree, late assistant geologist to the Victorian Geological Survey,* so that the propriety or otherwise of retaining this theory of the origin of our auriferous deposits in their lodes by the interaction of organic matter may be left in abeyance until Mr. Daintree publishes the results of his inquiry, as promised.

I will therefore leave the question in this state, merely observing that should Mr. Daintree be unable to obtain the results he is in search of, I shall then claim for our metallic sulphides the sole duty of depositing at least that portion of our native gold which occurs in the reefs or fissures of our metamorphic rocks.

ART. LII.—*Critical Notes upon the Alleged Nuclear Action of Gold upon Gold reduced from Solution by Organic Matter.* By W. SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 23rd October,* 1872.]

IN a paper upon the formation of gold nuggets which appeared in Part I., Vol. VIII., of the *Transactions and Proceedings* of the Royal Society of Victoria, the author, Mr. C. Wilkinson, states in reference to the question as to the origin of gold nuggets that "Mr. Daintree, formerly of our Geological Survey (that of Victoria) had on one occasion prepared for photographic use a solution of chloride of gold, leaving in it a small piece of metallic gold

* "Athenæum," 22nd July, 1871.

undissolved. Accidentally some extraneous substance, supposed to have been a piece of cork, had fallen into the solution, decomposing it and causing the gold to precipitate, which deposited in the metallic state, as in the electroplating process, around the small piece of undissolved gold, increasing it in size to two or three times its original dimensions."

The results alleged to have been obtained by Mr. Daintree appearing to have, and indeed being recognized as having, a very important bearing upon the popular question as to how our gold nuggets have been formed I have endeavoured to obtain further details, but in this I have been unsuccessful. Mr. Brough Smyth, indeed, in his work upon the Gold Fields and Mineral Districts of Victoria, refers to what appears to be the same experiment, but nothing further is there stated except that the size of the gold fragment started with is increased from a "speck" to a "piece." I have therefore tried to reproduce the results themselves, and having been unsuccessful I will describe minutely the several modes I adopted.

1st. ·1315 grammes of gold, hammered thin and bent to a curved disc of such a size as to expose about half a square inch of superficies, was placed in a glass vessel containing two ounces of a solution of auric-chloride of a strength equal to half a grain of gold per ounce. For reducing agents small pieces of cork and wood were sunk by glass attachments to the bottom of the vessel in close proximity to the disc of gold.

The vessel was then closed, put in a darkened place, and suffered to remain at rest until all the gold present in solution had been reduced, a process occupying in this case a period of time equal to rather more than two months.

The gold disc was then carefully examined and weighed. It had a small quantity of very finely granular gold loosely adherent to it, and apparently equally disposed over its surface.

With the whole of this loose gold attached the disc only increased in weight ·0005 of a gramme, or $\frac{1}{263}$ of its weight (a rate of increase that would require about forty-four years to double the size of the disc), consequently only about the $\frac{1}{130}$ part of the total amount of gold present in solution had deposited upon the disc, the remainder having deposited away from it, and this was seen to have indiscriminately attached itself to every surface which had contact with the auriferous solution, whether the bottom or sides of the vessel, the glass attachments, or even the surface of the liquid having contact only with the atmosphere.

In reference to the minute quantity deposited upon the gold disc it was found by numerical calculation that the proportion was certainly not more, relatively to the surface of the disc, than that which the remainder of the gold bore to the extent of the surfaces upon which it had affixed itself.

2nd. The same experiment repeated, but vessel and contents not darkened. Same results as before.

3rd. Gold solution reduced to half its strength, and time of total deposition extended to four months. Diffused sunlight admitted.

4th. Soluble organic matter used in place of wood; sunlight excluded. Time of total deposition of gold two months.

No discernible difference in results upon point in question to those obtained in experiment No. 1.

So far, therefore, as is shown by these results gold reduced from solution of its chloride by aid of such kinds of organic matter as cork or wood, does not in the manner of its deposition exhibit such a notable selective power for metallic gold as the description of Mr. Daintree's results would lead us to suppose. It does not, indeed, show any such selective process at all, that is to a greater extent than can be attributed to the action of surfaces generally regardless of their nature; and in support of this, I believe I am correct in stating that the whole sum of our experiences (omitting those of Mr. Daintree) is directly against this theory, as to the rapid and marked deposition of gold on gold in the manner stated; indeed, so far as I am aware, we only produce by these means fine incoherent powder—minute crystals or films of exceeding thinness—nothing nuggetty. We get a certain size of grain or crystal or a certain thickness of film, which our efforts have hitherto failed to enlarge.

Our experience therefore on this point being in such opposition to that of Mr. Daintree quoted above, and which he quiescently allows to be imputed to him, and the subject itself being a most important one, it does seem that the data upon which these apposite statements are founded should be ample, of a definite character, and clearly stated; but so far it does not appear by any means certain, from all I am able to gather on the subject, whether there was in reality any notable deposition of gold on the undissolved residue of gold, and if so, whether the reduction of this gold was solely effected by agency of organic matter. Thus Mr. Wilkinson states, "Accidentally some extraneous substance, supposed to be a piece of cork, had fallen into the solution, decomposing and precipitating the gold." Here then we are led to suppose that the vessel containing the solution, etc., was not closed. What, therefore, might not be reasonably supposed to have fallen in besides cork, or any other kind of organic matter? Pyritous dust, or even a small nugget of this substance, might have accidentally fallen in this solution, splintered off from some specimen which perchance Mr. Daintree himself might have been examining; pyritous matters generally being able, as I have shown, to reduce gold from such solutions, and to deposit it indefinitely upon gold or other electric conductor. Unless precautions had been taken, therefore, to prevent the introduction of reducing agents other than those coming under

the description of organic matter, it is impossible to credit the latter with producing the phenomena described. But granting that nothing except organic matter was administered to the solution, even then the evidence as to the enlargement of the "piece of undissolved gold" is exceedingly unsatisfactory.

Thus it appears from the manner of stating the matter that neither the weight nor volume of the "undissolved gold" was determined, the apparatus, etc., evidently not being arranged for any experimental inquiry at all. If then no such determinations were made at the outset, they would be of no value as applied to the piece of gold after the process of decomposition was complete. Consequently the statement that the undissolved gold was increased two or three, or several times, its volume, as Mr. B. Smyth states, is guess-work, for the correctness of which we are dependent upon the power of the eye to realize size, the power of the memory to retain a correct and distinct impression as to the size and shape of the gold piece at the outset, and further upon the proper working of the comparative faculty, in order that this image in the memory may be correctly compared with that which the enlarged nugget presented to the eye when the process was finished.

Obviously so many delicate processes are involved in this method of estimating size, that the results given cannot properly be taken as being absolutely correct, nor yet even to have such weight as to induce us to forego our present belief in the dispersion rather than the aggregation of gold precipitating from solution under the circumstances stated.

In the meanwhile, in cognizance of the tendency of gold to scatter when reduced from solution by organic matter, as manifested by my experiment here described, and by our previous experience in this matter, and on the other hand its tendency to agglomerate when reduced from solution by metallic sulphides, I cannot allow Mr. Daintree's results, as at present known to me, to affect me in any speculations I may make as to the origin of gold nuggets in drift.

ART. LIII.—*On the Absorption of Certain Alkaloids by Aluminous Silicates.* By W. SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 23rd October, 1872.*]

IF an aqueous solution of strychnia is agitated a short time with common clay it will be found on testing the mixture that a part or the whole of the alkaloid (according to the quantity used) has been removed from solution and absorbed by the clay. The same effects follow when the clay is

previously calcined. Morphia and narcotina may be substituted for strychnia with like results, other alkaloids I have not tried. Those cited can be removed from the absorbent by acids. From the results of numerous experiments I find that of all the silicates cyanite and andalusite (pure silicates of alumina) are the most effective absorbents of such bodies.

The silicates of the alkaline earths, or alkalies simple or compounded either among themselves or with silicate of alumina, appear quite negative to the alkaloids named. Wavellite and anhydrous sesqui-oxide of iron had no absorbing power for them.

These results show that the portion of the clay concerned in the production of the phenomenon instanced is silicate of alumina, and I should conceive a double silicate* to be formed, in every case hydrous, the anhydrous silicates of alumina named passing completely to the hydrous condition when finely comminated and moistened with water as I have previously shown (*Trans.* N.Z. Inst., Vol. IV., p. 380).

Art. LIV.—*On the Proposed Substitution of Acetate for Sulphate of Copper in the Manufacture of Iodine.* By W. Skey, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 23rd October*, 1872.]

The precipitation of iodine from the residual liquors obtained in its manufacture is at present accomplished by Soubeiran's method, namely by the addition of sulphate of copper thereto, iodide of copper thus forming and precipitating, but it is found in practice that the precipitation is so incomplete that a notable quantity of iodine remains in solution, necessitating the application of after processes for the more complete removal of iodine from such cupreous liquors.

In connection with this I would desire to make it publicly known that from certain investigations I have made upon this subject it appears that by a slight modification of Soubeiran's method this loss of iodine may be prevented, or so nearly that the necessity of after processes will be avoided.

The particular agents most active in causing this retention of iodine in the liquor are sulphate of copper, free sulphuric acid, and alkaline sulphates and chlorides, since they exercise a considerable solvent action upon the iodide of copper formed in Soubeiran's process.

* Since the communication of this paper I find that silica chemically prepared and rendered anhydrous by heat will also absorb strychnia from aqueous solution, clearly showing that at any rate single silicates of the alkaloids readily form.

The modification therefore which I propose is the use of acetate of copper in place of the iodide, this salt, as also free acetic acid and alkaline acetates, dissolving the cupreous iodide to only a very slight extent.

For practical use this salt might be prepared from common sulphate of copper by adding thereto acetate of soda in quantity sufficient to allow of the whole of the sulphuric acid of the copper salt being interchanged for acetic acid, but for the more complete removal of iodine I should recommend the use of the acetate of copper alone.

I will only state further that the pure acetate of copper (acidified with acetic acid if necessary) is so delicate a test for iodine, if in the form of a soluble iodide, that it may very effectively and conveniently be used for this purpose in place of the expensive salt, chloride of palladium ; indeed, by this process I have readily detected iodine in certain waters from the east coast of this (North) Island.

ART. LV.—*On the Formation of Gold Nuggets in Drift.* By W. SKEY, Analyst to the Geological Survey of New Zealand.

[*Read before the Wellington Philosophical Society, 23rd October,* 1872.]

THE manner in which those gold nuggets have been formed which are found in our drift or fluviatile deposits has long been a subject of profound interest. Our Victorian friends in particular have been greatly exercised with this matter, no doubt from having it so frequently and forcibly presented to them by the almost regular announcement from time to time of the discovery of nuggets so large as to be entitled to description in the annals of their gold fields, and to names to identify them by.

From the circumstance of their attention being thus given to this subject many valuable observations have been recorded by them and published in the periodicals or other works emanating from their colony.

The first theory broached to account for the presence of these nuggets in drifts was that they had been broken off some rich reef and transported by water bodily to the positions in which they are now found by us. At first sight this appears very plausible, but there are several considerations which, when allowed to have their due weight, rather tend to shake our belief in its competency to explain the case. These considerations have been discussed pretty freely in the works alluded to so I need not detail them here, but will only state that, briefly put, the chief of them are as follows:—The large size of many of these nuggets as compared with any of the masses of gold yet found in our reefs; their position in the drifts, lying sometimes as they do in the

upper layers; and their superior fineness of quality as compared with that of any of the reef gold found in their vicinity.

Impressed by these facts Mr. A. C. Selwyn proposed another theory for explaining the origin of these nuggets, and one which certainly appears to meet the question upon the particular points just cited. This theory is "that nuggets may be formed and that particles of gold may increase in size through the deposition of gold from the meteoric waters percolating the drifts, which water, during the time of our extensive basaltic eruptions, must have been of a thermal, and probably of a highly saline character, favourable to their carrying gold in solution."*

At the time this idea was broached nothing systematic or thorough had been undertaken towards investigating this matter as to the probable presence of gold in those meteoric or saline waters referred to, and nothing whatever had been accomplished towards showing any likely means by which gold, depositing from such solutions, would be determined upon itself as a continuous coating, and in such quantity as occasionally to form nuggets of the enormous size we find them in such drifts, nor did Mr. Selwyn indeed make any suggestion on this matter; perhaps considering the initiation of such an idea sufficient for his part, he left the support of it to the ingenuity of chemists, to whom in fact such a labour rightfully belonged; in reality, so little was known in support of this theory at the time of its evolution that it seemed in the highest degree chimerical. Since then, however, chemical investigations have given us results greatly in favour of this idea. Thus in the first place as regards the presence of gold in a soluble state in the waters percolating our drifts, it appears that Mr. Daintree found gold in pyrites which had obviously replaced the organic structure of a tree occurring in a drift-bed, and Mr. Newbery, Analyst to the Geological Survey of Victoria, afterwards obtained the same results upon other pyrites occurring in a similar manner, both results showing that gold must have been "presented to the pyrites in a soluble form."

Since that time gold has been by no means unfrequently discovered to be present in certain mineral and mine waters, and indeed Mr. Daintree has recently found gold while testing the water of a mine in Victoria.

Perhaps, though, the most important communication we have relative to this subject is that of E. Sonstadt, "On the Presence of Gold in Sea-water," ("Chemical News," 4th October, 1872). This metal has indeed before this been alleged to exist in sea-water, bnt these allegations have not been sustained with such evidence and accompanied with such detailed description of processes employed as entitled them to an unreserved belief on our part. Son-

* "Trans. & Proc. Roy. Soc. of Victoria," Vol. IX., p. 53.

stadt's experiments on the other hand are detailed minutely, and his statements are supported by the results of different processes.

The amount of gold present in the water taken from Ramsey Bay, he states to be very minute, "less than one grain in the ton," still the fact of its presence at all in such water is exceedingly interesting as showing an escape of gold from the land seaward, and so confirms the correctness of the various allegations I have referred to respecting the auriferous character of certain of our springs and mine waters.

Thus in different ways the first question involved in this theory of Mr. Selwyn is answered in a most satisfactory manner.

As to the means by which the gold present in these waters has been reduced therefrom and aggregated in masses, solid, homogeneous, and occasionally of considerable size, we have no lack of substances certain to be present in these drifts, and capable of effecting the reduction of gold and silver from the kind of solutions likely to be present there. In various kinds of organic matter and in sulphate of iron we have substances which will effect this with facility, but we have no sure evidence as yet to show that either of these substances will aggregate the gold, which they reduce or locate in a marked manner, or preferentially, upon the gold already reduced.

That gold will be reduced by these substances is certain, but all our present experience in regard to the deposition of gold by them shows that gold so reduced will be dispersed rather than aggregated, so that it would appear that nuggets of gold could not well be formed in this manner.

In our mineral sulphurets, however, we have agents which are not only capable of reducing gold and silver from solution, but besides are capable of locating them when so reduced in coherent and bulky masses.

I may state that their nuclear action upon gold depositing from solution by aid of organic matter was suggested by Mr. Charles Wilkinson,* while their competency to reduce the gold from solution without addition of organic matter was shown by me in Vol. III. of our *Transactions*, pp. 227–230; thus the aggregation of the nuggetty forms of gold from solution becomes a still more simple matter, only one reagent being necessary, so that there is a greater probability of such depositions obtaining than were a double process necessary.

Knowing the action of sulphides, the manner of the mode of formation of a portion at least of these nuggets seems apparent. Conceive a stream or river fed by springs rising in a country intersected by auriferous reefs, and consequently in this case carrying gold in solution; the drift of such a country must be to a greater or lesser extent pyritous, so that the *débris* forming the beds of these streams or rivers will certainly contain nodules of

* "Trans. Roy. Soc. Vict.," Vol. VIII., Art. II.

such matters disseminated, or even topping them in actual contact with the flow of water.

It follows then from what has been previously affirmed, that there will be a reduction of gold by these nodules, and that the metal thus reduced will be firmly attached to them, at first in minute spangles isolated from each other, but afterwards accumulating and connecting in a gradual manner at that point of the pyritous mass most subject to the current, until a continuous film of some size appears; this being formed, the pyrites and gold is to a certain extent polarized, the film or irregular but connected mass of gold forming the negative, and the pyrites the positive end of a voltaic pair; and so according as the polarization is advanced to completion, the further deposition of gold is changed in its manner from an indiscriminate to an orderly and selective deposition concentrated upon the negative or gold plate.

The deposition of gold being thus controlled, its loss by dispersion or from the crumbling away of the sustaining pyrites is nearly or quite prevented—a conservative effect, which we could scarcely expect to obtain if organic matter were the reducing agent.

Meanwhile there is a gradual wasting away of the pyrites or positive pole, its sulphur being oxidized to sulphuric acid, and its iron to sesqui-oxide of iron or hematite, a substance very generally associated with gold nuggets. According to the original size of the pyritous mass, the protection it receives from the action of oxidizing substances other than gold, the strength of the gold solution, length of exposure to it, and rate of supply (velocity of stream), will be the size of the gold nugget.

As to the size of a pyritous mass necessary to produce in this manner a large nugget, it is by no means considerable. A mass of common pyrites (bi-sulphide of iron) weighing only about twelve pounds being competent for the construction of the famous "Welcome nugget," an Australian find, having weight equal to 152 lbs. avoirdupois

Such masses of pyrites are by no means uncommon in our drifts or the beds of our mountain streams. The general velocity of the current flowing over such pyritous matters would in all probability be such as would prevent the development of any crystalline form in the gold thus deposited, as we know very well that for such development motion is unfavourable. The form most likely to be assumed by these deposits then would be the mammillary, precisely that in which our nuggets as a rule occur.

Upon this mode of accounting for the presence of large nuggets in our drifts, their occasional great superiority in point of size to any auriferous mass as yet found in our reefs, and their superior fineness to such reef gold, admits of easy explanation.

Firstly, as regards their comparative size, if we only admit that reef gold

is also deposited by pyrites, as I attempted to show in the paper just alluded to, and if we assume that the strength of the gold solutions forming these varieties of gold respectively was not greatly different, it is only reasonable to suppose that the gold masses formed in this manner in drift would attain the greatest dimensions, for in the first place this gold in depositing would certainly aggregate more as the pyrites in the drifts or river beds would be less continuous and more sparsely distributed than that in reefs.

Secondly, the supply of gold to pyrites lying in these drifts or river beds (and so exposed to rapidly changing waters) would be far more copious than to pyrites cooped up in a rocky fissure, and so in contact only with water stagnant or nearly so.

And, thirdly, as regards the generally superior quality of these nuggets to gold found in the reef, it will, I think, appear from the following considerations that such a difference in favour of drift gold is to be expected.

I have previously shown* that silver is deposited with greatest rapidity and certainty upon pyrites from solutions which are alkaline from presence of the fixed alkalies or alkaline earths, and that as such solutions are passed from this condition to an acid one the silver present in them is retained in solution; any gold, however, that may be mixed with such silver is deposited upon this reducing agent, no matter which of these conditions the solvent is in.

Now this alkaline condition is precisely that in which, as far as we can ascertain, our lodes or rocks must have been at the time of the deposition of the gold and silver now found in them, and this alkalinity would especially manifest itself in those reefs which traverse rocks of a basic nature, such as diorites or serpentines: hence, by the way, the large proportion of silver alloying the gold found in these reefs, as compared with that alloying the gold found in the lodes of our schists or older formations.

But though the waters percolating our reefs must be to a more or less extent of an alkaline nature the drainage waters issuing from them will lose a portion of this alkalinity as they are exposed to the air, or to the products of decomposing organic matters, from having absorbed a quantity of carbonic or other acids (sulphuric, humic, etc.), thus in some measure, according to the distance such waters have travelled from their springs, will their condition be changed until their alkalinity may give way to neutrality, or even acidity, either of which conditions are, as I have stated, unfavourable to the liberal deposition of silver along with gold from such waters. Hence it is apparent that from the instant the waters percolating rocks or lodes leave them to form springs, etc., they are continually passing from a favourable condition to one eminently unfavourable for the deposition upon pyrites of what silver they

* *Trans.* N.Z. Inst., Vol. III., Art. XL.

may contain. Consequently the deposition of gold from solution being as we know unaffected, or but slightly so (comparatively), by the condition of the solvent, the great purity of gold deposited from these surface waters is explained.

The above explanation of the greater purity of our alluvial or drift gold over gold found in the reef is, I think, much more plausible than that which attributes this difference to the interaction of solutions of gold upon the auriferous masses transported from the reef, whereby the silver of these masses is replaced by gold and so removed, leaving the mass correspondingly richer in gold. That this process can be continued until our largest auriferous masses can be thus affected throughout appears to me impossible when we consider the imperviousness of such metallic masses to liquids, and how nearly the atomic volumes of gold and silver approximate. That a superficial change, however, in this direction may occur is by no means improbable, but such would escape detection unless it were especially sought for. Thus the hypothesis advanced by Mr. Selwyn as to the manner in which the nuggets of our drifts may have been formed receives support upon all those points which appear of any importance.

That nuggets of some size may, however, be in a few instances transported bodily from these matrices into the drifts or water-courses is by no means improbable, but in this case they would, I think, partake of the usual quality of the reef gold of the country about, and so would be inferior in this respect to gold formed in the manner above described.

Whatever may be the origin, however, of any particular nugget, or of nuggets generally, when we consider the auriferous nature of many mine waters, also that of sea-water, together with the decomposing and aggregating action of metallic sulphurets upon the gold of these waters, we cannot avoid the conclusion that gold is now being deposited and aggregated in many of our drifts, and that such depositions have been going on from remotest times.

In conclusion, the questions as to the source of the gold of our nuggets, the nature of the agencies by which it is dissolved, and the precise chemical state in which it exists in our auriferous waters, are subjects which it is not incumbent upon me to discuss here. I will, however, take leave to make a few observations upon them now.

As regards their source I think this is rather in gold as disseminated in certain of our slate, sandstone, or schist rocks, than in that of our reefs.

In reference to the nature of the solvent I have shown* that sulphuretted hydrogen attacks gold at ordinary temperatures, forming a sulphide of the metal, and we know that all the sulphides of this metal we have to this time formed are soluble in alkaline sulphides; therefore, as both these agents are

* *Trans.* N.Z. Inst., Vol. III., Art. XXX.

generally present in waters situated at some depth in our rocks, we may very reasonably suppose that a portion, if not all, of our gold has been brought into solution by these agents.

The state to which such auriferous solutions might pass when exposed to air and carbonic acid is not easy to determine, but of this we may be certain, that it could not well be one unfavourable to the exercise of the reducing properties of metallic sulphurets upon the gold compound present in them.

V.—GEOLOGY.

Art. LVI.—*On the Date of the Last Great Glacier Period in New Zealand.* By Capt. F. W. Hutton, F.G.S.

[*Read before the Wellington Philosophical Society, 18th September,* 1872.]

It is an acknowledged fact that the glaciers of the South Island of New Zealand have been at some former time of much larger dimensions than they are at present, and to the period of their greatest extension Dr. Haast has applied the term "Glacier Period." This term is a very convenient one, and I shall here adopt it with the understanding, however, that it has no relation to, and implies no contemporaneity with, the "Glacier Epoch" of the Northern Hemisphere; for although Dr. Hector ("Geo. Mag.," 1870, p. 70; N.Z. Exhibition Jurors' Reports, p. 263; *Trans.* N.Z. Inst., II., p. 372; "Quar. Jour. Geo. Soc.," 1865, p. 128; and Anniversary Address to the Well. Phil. Soc., 1872), and Dr. Haast (Formation of the Canterbury Plains, pp. 7, 14, etc.) refer our last glacier period to pleistocene times, that is to about the same time as the glacial period of Europe, I think I shall be able to show that it is in reality far older, or at any rate that the subject is one that admits of discussion.

No New Zealand geologist advocates now a cold or glacial period to account for the former extension of our glaciers, for, as Dr. Hector has pointed out in his anniversary address for this year, there are no signs of any till or marine formed boulder-drift to be seen, and our pleistocene and newer-pliocene fossils show that no very great reduction of temperature has occurred in these latitudes since those times*. In the pleistocene deposits of Wanganui we find *Triton spengleri*, *Cassis pyrum*, and another extinct species of the same genus, *Ancillaria australis*, *Turbo granosus*, *Imperator imperialis*, *Rotella zealandica*, and *Labio zealandicus*, as well as *Mesodesma chemnitzii* and *M. cuneata*, none of which probably would have been able to survive a reduction of temperature sufficient to cause so great an extension of our glaciers as we know to have taken place.

In the newer-pliocene beds which form the lower series at Wanganui (Geo. Reports, 1872, p. 182) we also find a *Typhis*, the same extinct species of

---

* It can by no means be inferred from this that there has been no "Glacial Epoch" in the Southern Hemisphere, for no glacial (as distinguished from glacier) phenomena are found in Europe south of 50°, and it is probable that if no land now existed north of that parallel of latitude the occurrence of a glacial epoch would never have been suspected.

Cassis that is found in the upper series, *Ancillaria australis,* two species of *Calopoda* one of which is still living, *Imperator imperialis* and *Rotella zealandica,* showing that here also we cannot call to our aid any great diminution of temperature. We have no marine deposits in New Zealand of older pliocene date, for, as I shall subsequently show, the land then stood at a much higher level than it does at present, consequently we have no proofs here, either one way or the other, of a change of climate, but as the elevation of the land would, if high enough, be able by itself to account for all the phenomena, there is no necessity for calling to our aid any other cause. During miocene times our climate was warmer than at present, as is proved by fossils of the genera *Conus, Mitra, Marginella, Crassatella, Limopsis, Perna,* and the large species of *Cucullæa* and *Cardium* which then inhabited our seas.*

We must therefore necessarily infer that the greater extension of the glaciers was caused by greater elevation of the land†, and their subsequent reduction in size was caused by subsidence, and so far Dr. Hector, Dr. Haast, and myself agree. Dr. Hector, however ("Jour. Roy. Geograph. Soc.," 1864, p. 103, and "Geo. Mag.," 1870, p. 70), and Dr. Haast ("Cant. Plains," p. 14, and "Quar. Jour. Geo. Soc.," XXI., p. 131) appear to attach considerable importance to the erosion of the vallies by the glaciers reducing the area of land above the snow line. This appears to me to be an unnecessary and exaggerated view of the rapidity of glacier erosion‡, and the fact that eocene or miocene marine rocks are found far up many of these vallies, such as at the Rakaia, Canterbury, and some twelve miles above Queenstown in Lake Wakatipu, proves beyond dispute that they had attained to nearly their present size in eocene times. Dr. Hector also assumes (*Trans.* N.Z. Inst., II., p. 373) that the chief erosion, by which the vallies are eaten back by the glaciers, takes place at the abrupt fall known as the "ice cascades." But the friction, and therefore the power of erosion, of any solid body like ice must vary as the cosine of the angle of inclination, and consequently the greater the slope the less the erosion. The maximum of erosion must necessarily be at the upper angle of the ice cascade, where the ice bends downward by its own weight, and consequently the effect would be the gradual reduction of an abrupt fall to one of gentle inclination, and this is fully borne out by the fact

* This is the usual palæontological argument, but I believe that, when applied to extinct species, it may lead to very erroneous deductions, and that when opposed to physical arguments it is of no weight at all.

† An elevation of from 2,000 to 3,000 feet would be sufficient to account for all the phenomena, while an elevation of 550 feet would connect the two islands.

‡ On this subject see an excellent paper by the Rev. T. Bonney in the "Quar. Jour. Geol. Soc.," 1871, p. 312.

that the majority of glaciers have no ice cascade at all, and nearly all partake more of the character of "ice-rapids" than "ice-falls." As this point, however, is of minor importance it is not necessary to pursue it any further.

Dr. Hector and Dr. Haast base their opinion that our last glacier period was in pleistocene times on the supposition that since then great subsidence has taken place. I will, therefore, in the first place give the reasons that have led me to an opposite conclusion, viz., that during the whole of the pleistocene period elevation has been more or less continuous over the greater part of New Zealand, and I will then give the evidence in favour of the glacier period having been in older-pliocene times.

It is so universally acknowledged among geologists that river terraces prove elevation, that it is quite unnecessary for me to go over again such well trodden ground.* There may be some cases where, in a mountainous country, rock-bound lakes have been filled up before the outflowing river had cut down through the rocky barrier to its normal level, and where consequently terraces might be afterwards formed in the old lacustrine deposits as the level of the river was lowered, or where a stream of lava from a volcano has blocked up the course of a river, and thus led to a similar result; but these are exceptional cases which can always be recognized by the terraces being formed of stratified silt or fine sand, but never of shingle, and it cannot possibly apply to rivers running through plains or broad vallies. Now throughout the South Island of New Zealand on both sides of the Alps, and in the central portions of the North Island, all the rivers appear to be deeply terraced. I know, from personal observation, that this is the case with the rivers of Southland, with the Aorere in Golden Bay, and with the Waipa and Waikato in the province of Auckland. Dr. Haast describes the same thing with the rivers flowing into the Canterbury Plains. (Report on Cant. Plains, Christchurch, 1864.) Mr. Buchanan describes terraces in the vallies of the Awatere and Eden rivers (Geo. Reports, 1866–67, p. 41), Dr. Hector describes those of the west coast of the South Island (Progress Report, 1866–67, p. 29) including the Buller (l.c., p. 32), and also of the Mohaka (Geo. Reports, 1870–71, p. 160) in the province of Napier, and Dr. Hochstetter ("New Zealand," p. 467) and Mr. Travers ("Quar. Jour. Geo. Soc.," 1866, p. 259) describe those of rivers in the province of Nelson.

But there are many other proofs of recent elevation besides that afforded by the river terraces. The Southland plains show unmistakable marine action. Towards its mouth the Jacobs River runs through extensive deposits

*Consult, *inter alia*, Lyell's "Elements of Geology," 6th ed., pp. 118 and 120, and his "Student's Elements," p. 79; Dana's "Manual of Geology;" "Geological Magazine," 1871, pp. 75, 190, 239, 333, 430, 526, 574; ditto, 1872, p. 48; Ramsay's "Physical Geology of Great Britain," p. 109; Jukes and Geikie's "Manual of Geology," p. 402.

of limestone and calcareous sandstone of upper-eocene age; these rocks are all planed down to a uniform level and covered by a thin layer of silt and gravel, which is at the same altitude as the thick gravel beds that form the other parts of the plain; the same thing on a smaller scale occurs in the Waimea plains, in Southland, where the eocene limestone is also covered with gravel, and cannot be distinguished in outline from the terraces; we know of no agency but marine denudation that could effect this. The seaward plains show their origin still more distinctly by their uniform level all round the southern face of the Hokanuis, and from the terraces being sometimes arranged more or less parallel to the present coast. It is no objection to the marine theory that beds of lignite are found under these deposits, on the contrary it is much in favour of it, as it is well known that vegetable remains are very sparingly distributed in river alluviums, for they are scattered widely by the currents, while, on the other hand, we know that most coal seams are covered by marine beds. Indeed the occurrence of vegetable remains on a large scale below alluvial plains is a certain proof that those plains were formed either by lakes or by the sea, and not by rivers. These vegetable deposits accumulated during the depression which preceded the elevation.

Of the Canterbury plains I speak with much diffidence as I have not visited them, and because Dr. Haast, after a careful examination, has come to the conclusion that they have been formed by the rivers during a long course of depression (Report on the Canterbury Plains, 1864), but judging from the sections that he gives in his report I cannot understand how they can have an entirely fluviatile origin, for in a line parallel to the coast they are nearly level from the Waimakariri to the Rangitata, the highest portion being about the Waimakariri. Now each of the rivers must have poured out an amount of detritus proportional to its size, and therefore the plains should be higher about the larger rivers than about the smaller ones; but the fact is that the country about the Hinds and Ashburton, two small rivers, is higher than that about the Rangitata, a large river, and nearly as high as that about the Rakaia, the largest river on the plains. If we suppose that the larger rivers after raising their own beds wandered about the plains helping the smaller ones, I can then see no reason why all the smaller rivers should have afterwards left the common channel, and each pursued its own way direct to the sea. Neither does Dr. Haast explain how it is that the gravel formation of the plains wraps round the spurs of the hills at the same level that it has at the river gorges, nor how it is that the plains of the Rakaia and Waimakariri are nearly at the same level on each side of the Malvern hills, while the beds of the rivers are at very different levels, nor why the tertiary rocks between the junction of the Kowai and the Gorge hill, and at the gorge of the Rakaia, are levelled on the top. Dr. Haast not only believes in a general

subsidence, but also that this subsidence has been greater on the west than on the east coast; consequently, according to his theory, the velocity of the rivers must have been considerably reduced, and he has not informed us how it is that they have been enabled with their reduced velocities to cut through and remove the alluvium which they could carry no further, but deposited when their velocity was greater.

All these things, as well as the occurrence of vegetable deposits below the gravel, are readily explained by supposing the plains to be a marine formation since elevated, but are, I think, quite inexplicable on the river formation theory alone. I might also fairly ask, if rivers form such large level plains in New Zealand why do they not form the same in other countries? Why are there no broad level gravel deposits like the Canterbury plains round the foot of the Himalaya, Alps,*, etc.? My answer would be because none of these places have been lately submerged below the sea.

That the greater part of the shingle of the Canterbury plains has been brought down by the rivers from the mountains I do not dispute, and I also acknowledge that, as the plains were elevated, the rivers must have often changed their courses and wandered over a large part of the plains near the then shore line, all that I contend for is that the materials brought down by the rivers have been rearranged by the sea, and the shape of the stones would therefore depend upon the length of time that they had been subjected to wave action, and on the amount of sand in which they are imbedded. The silt deposit upon which a large part of the town of Lyttelton is built is also evidently a recent marine deposit, but I do not know to what height it extends above the sea.

Mr. W. T. L. Travers has pointed out to me that the land side of the hills forming Banks Peninsula shows no trace of marine erosion, and this is the most formidable objection to the elevation theory that I have as yet met with. It would be very easy to say that as Banks Peninsula is volcanic it may have been thrown up or elevated more rapidly than the plains, and at a later date, but there is no proof of this, and until that can be given I could not accept it as an escape from the difficulty, but we must remember that the land side would not have been exposed to a heavy surf, and that the rapid decomposition of the volcanic rocks might soon obliterate all traces of a sea cliff. Mr. C. Forbes states ("Q. J. Geo. Soc.," 1855, p. 526) that "there is abundant evidence to prove that at a very recent period the Peninsula was an island." The absence of fossils in the Canterbury plains is easily explained, indeed we could hardly expect any to occur, for those shells that were not completely pounded to pieces on the shingle beach would be rapidly dissolved out, on

* The gravel deposits of Switzerland are of quite a different character, and are the *grundmoränen*, or *moraines profondes* of glaciers.

emergence above the sea-level, by the ready percolation of rain-water containing carbonic acid through such porous strata.

Dr. Haast also describes at Timaru (Report on Timaru district, p. 4) silt, underlaid in places by fine clay or gravel, covering basalt, and sloping up from the sea to a height of 686 feet, and containing recent marine shells near the sea (Cant. Plains, p. 8).

Mr. Hacket gives evidence (Geo. Reports, 1868–69, pp. 10 and 11) of a rise of the land near the Okarita and Waikukupa Rivers, on the west coast of the South Island. It is evident that the deposits he here describes are not ordinary morainic accumulations, but it remains yet to be proved whether these beds were deposited in a lake or in the sea, or whether they are of morainic origin at all.

Dr. Hector, in describing the gold fields of the west coast of the South Island (Progress Report, 1866–67, p. 29), says that the gold drifts have been "carried out from the mountains by the rivers, and deposited upon a gradually changing coast line. They thus have a general distribution parallel to what was the western shore of the island at the epoch of their deposit; and by tracing the successive lines of elevation, and allowing for the consequent changes which have occurred in the direction of the drainage channels of the country, we are enabled to form an opinion as to the extent and position of the auriferous leads." Further on he speaks of the first group of auriferous alluviums as being the "earliest formed and most elevated of these drifts," but he does not give the height to which it attains; but the third group he calls "beach terraces which extend to an altitude of 220 feet, and mark several changes in the level of the shore line within a comparatively recent geological period," so that we must infer that the first group attains a greater height than 220 feet.

At Taranaki, Dr. Hector also describes (Progress Report, 1866–7, p. 3), "pleistocene deposits consisting of stratified gravels and sand-rock, with beds of lignite," reaching an altitude of 150 feet above the sea, which he says "must be regarded as in some way connected with an ancient coast line, and from the circumstance that at the base of this formation in many places, and underneath the lignite seams, there is a layer of rolled broken shells of existing species, we may infer that these gravels have been deposited in lagoons parallel with the coast line during a gradual elevation of the land, and that they have been overtaken, as it were, by the encroachment of the sea, and exposed in the sea cliffs after they are 80 to 100 feet above the present level of the tide."

Mr. R. Pharazyn, in a paper read to this Society (*Trans.* N.Z. Inst., II., p. 158), gives evidence of recent elevation near Wanganui; and Dr. Haast (Report on the Cant. Plains, p. 8) at Timaru.

In the Nelson province Mr. W. T. L. Travers also ("Quar. Jour. Geo. Soc.,"

1866, p. 256) describes extensive deposits of post-pliocene gravels and sands, the materials of which "are all water-worn, and exhibit the common appearance of river or beach shingle." These deposits attain an altitude of more than 2,000 feet above the sea; they "are in no way cemented, very little inclined in stratification, and in many places exhibit perpendicular sections several hundred feet high;" they can, therefore, hardly be due to river action.*

The sandy beds at Wanganui contain about 10 per cent. of extinct shells, and must therefore be referred to the earlier part of the pleistocene period, that is, the glacial epoch of Europe. I do not know to what height above the sea they attain, but Dr. Hector states ("Cat. Col. Museum," 1870, p. 172) that they are 100 feet thick at Wanganui. Raised beaches of pleistocene, or of almost recent, age are found at Motanau, in Canterbury, and on the north-west side of Cape Kidnappers, in Hawke Bay, but I do not know their altitude. On the north-west side of Hicks Bay, near the East Cape, there is a very distinctly marked line of inland cliffs; and the same thing is seen in Cook Strait, near Wellington.

Besides all this evidence, Dr. Hector admits that recent raised beaches, from 15 to 25 feet above the sea level, are found in places all round the coast.

The objections which Dr. Hector raised, in his anniversary address to our Society for this year, to a recent elevation of New Zealand, or rather the reasons he adduced in favour of recent subsidence, are:—

1. That vallies on the west coast of Otago, in the northern parts of New Zealand, and in other places, are depressed far beneath the level to which they could have been eroded, and that they are prolonged beneath the water level, forming deep water inlets and harbours. I quite agree with Dr. Hector that these vallies must have been eroded when the land stood far higher than it does now; but they afford no proof of a recent depression, for, as I have already stated, we have unmistakable evidence in the eocene and miocene tertiary rocks found far up some of them that they were formed in the earliest tertiary times, and they no more prove recent subsidence in New Zealand than similar fiords do in Norway, Tierra del Fuego, and the west coast of Scotland, all of which are known to have risen during pleistocene times.

2. That "the low shelving and sandy parts of the coast have a heaped up shore line, that appears as if encroaching on the alluvial deposits." I do not know to what particular parts of the coast Dr. Hector alludes, but this appears to me to be no evidence, either one way or the other, for if the conditions were favourable for the formation of sand-dunes, they would appear to encroach on the recent marine deposits, as they rose above high water-mark, in the same way that they would be formed over alluvial deposits when sinking.

* Since writing the above I have examined these beds and find that they are of præglacier date, and consequently have nothing to do with the present argument.—F.W.H.

3. That with the exception of a raised beach, nowhere raised more than 20 feet above the sea level, "there is a total want of any inland cliffs, lines of sand-dunes, and ridges, and other familiar evidences of an emerged coast line." I do not think that inland cliffs can by any means be called "familiar evidences of an emerged coast line," because everywhere they are the exception and not the rule. Nothing is so soon obliterated as an inland cliff, and few things are rarer to find, except close to the sea; but I have already quoted Dr. Hector himself as mentioning beach terraces on the west coast of the South Island which attain a height of 220 feet above the sea; and I have also mentioned inland cliffs in Cook Strait, and near East Cape, both of which are certainly more than 100 feet above the sea level. Mr. Traill also describes (*Trans.* N.Z. Inst., II., p. 169) an old sea beach near Oamaru, "elevated considerably above the present one." Mr. P. Thompson describes (*Trans.* N.Z. Inst., III., p. 263) two series of sand-dunes at Wickliffe Bay, in Otago, one much older than the other, and covered with grass; and in his "Catalogue of the Colonial Museum," Dr. Hector classes the Upper Wanganui series as a raised beach. Mr. Buchanan also gives a section (Geo. Reports, 1866–7, p. 36) showing pleistocene gravels containing marine fossils at a considerable elevation above the Clarence River, in Marlborough.

4. That "the low.country is invariably formed of marine strata of higher antiquity than the period of the extension of the glaciers." As Dr. Hector supposes the extension of the glaciers to have taken place in pleistocene times it is of course difficult to find any strata younger than this; but even on his view the pleistocene beds at Wanganui and Taranaki must be either younger than, or of the same age as, his glacier period; and if I am right in referring the glacier period to older-pliocene times, we have the newer-pliocene beds of Shakspeare Cliff and Patea, younger than the glacier period.

5. That the Canterbury plains have been "overwhelmed by shingle deposits brought from a higher level by the rivers," and have an old drift-wood bed below them at 80 to 90 feet below the level of the sea. This point I have already discussed, and shown, I think, that as yet it is far from certain that these plains have been formed altogether by the rivers. The drift-wood bed simply proves oscillation of level, and it was probably formed during the subsidence that took place in newer-pliocene times, and is perhaps older than the lower Wanganui beds of Shakspeare Cliff.

6. That there is no pumice drift at high altitudes in land-locked harbours like Wellington, although it is found at low levels. On this I would remark, that the seaward slopes round all these harbours are very steep, and that pumice is very light, and easily washed away. It also very rapidly decays when kept wet, much of that which comes down the Waikato being half rotten already. These causes are, I think, sufficient to account for the disappearance of pumice in the course of time.

7. As a last reason, Dr. Hector cites my paper on the Lower Waikato deposits, read before the Auckland Institute (*Trans.* N.Z. Inst., III., p. 244), in which I state that there is no evidence of the sea having ever been in the Lower Waikato valley. This I certainly think shows that the Lower Waikato district has not risen more than 50 feet during the pleistocene period, but it does not affect other parts of the Island. Indeed, there can be no doubt that the elevation has been very unequal in different districts. The central portion of the North Island appears to have risen most, and next to that the central portion of the South Island, while the whole of the northern portion of the province of Auckland does not seem to have risen more than 20 or 30 feet, but we are almost without data at present to estimate these differences correctly.

I do not think, therefore, that the reasons brought forward by Dr. Hector by any means prove that subsidence has been going on during the pleistocene period, on the contrary I believe that nearly the whole of the evidence is in favour of elevation.

At Shakspeare Cliff, Wanganui, and at Patea, in the province of Wellington, we find marine strata containing fossils of which about 24 per cent. are extinct. These beds must be referred to the newer-pliocene period, and this, therefore, cannot have been the time of elevation and extension of the glaciers.

The next set of beds, however, below these contain about 59 per cent. of extinct species, thus proving that a long interval of time must have elapsed between their deposition and the newer-pliocene period, which is quite unrepresented in New Zealand by marine strata. I refer these lower beds, which are found at the Awatere, the Port hills at Nelson, the White Cliffs of Taranaki, Awamoa, etc. (see Geo. Reports, 1872, p. 183), to the upper-miocene period; and it is therefore the older-pliocene period that is unrepresented.

But not only is there a great difference between the fossils of these two formations, but there is also a great difference in their stratigraphical position, and in the amount of sub-aerial denudation that they have respectively undergone. The older formations always show a broken outline, deeply eroded into hills and vallies, and in some places the beds are tilted at high angles; while where the newer-pliocene beds form the surface level plains cut by narrow ravines only are found (Pharazyn, *Trans.* N.Z. Inst., II., p. 158). These facts are, I think, sufficient to prove that the older-pliocene period was a period of upheaval, and it is therefore to this time that I refer the last great extension of our glaciers. If Dr. Hector's views are correct as to the glacier period having been in pleistocene times, we shall have to find some reason for the newer-pliocene deposits not being more denuded than they are; for, according to this theory, they once stood at a much higher level than they have at present.

But independently of all these reasons we find, I think, in the marks of former glaciation themselves strong evidence of a very ancient date. In Otago, about Lake Wakatipu, which is the only glacier region in New Zealand that I have had an opportunity of examining, the evidence of the former extension of the glaciers rests almost entirely on the presence of moraines and *roches moutonnées*, which are the most permanent marks that a retreating glacier leaves behind it. All the more perishable ones, such as *blocs perchés* and striæ, are almost entirely absent. I searched in vain on some beautifully rounded surfaces of rock near Queenstown for striæ, but all had been obliterated by decomposition, and the only striæ that Mr. J. McKerrow and myself could find were on a few loose boulders at the head of the lake. The absence of striæ, *blocs perchés*, and other well-known glacier marks, forms a remarkable contrast to what obtains in the Alps, North Wales, and the south-west of Ireland, all of which districts I have personally examined, and this alone would make me refer our glacier period to a time long antecedent to the glacial period of Europe. Striæ may be more common in other parts of New Zealand where the rocks are harder than they are in the South, but the absence of any descriptions of them in the reports of Dr. Hector and Dr. Haast, beyond general statements that such exist, makes me think that they must be far from common.

I am therefore of opinion that the last great extension of our glaciers was in older-pliocene times, when the land stood far higher than it does now; that the newer-pliocene was a period of subsidence, followed by elevation in the pleistocene period, and that that elevation is probably still going on.

NOTE.—November, 1872. The fact that several species of birds and insects are different on the two islands of New Zealand would be considered by nearly all naturalists as a good proof that these islands have been separated longer than Great Britain from Europe, that is to say, previous to the pleistocene period;* but an elevation of 500 feet would obliterate Cook Strait and join the two islands together, consequently New Zealand cannot have stood at an elevation 500 or 600 feet higher than at present since the pliocene period. We are, therefore, driven to adopt one of two suppositions, viz., either that the former extension of the glaciers was caused by an intense cold or glacial period, or by elevation of the land in præ-pleistocene times.—F. W. H.

* Godwin-Austen, "Quar. Jour. Geo. Soc.," VI., p. 94.

On the Formation of Lake Wakatipu. By Capt. HUTTON.

The formation of Lake Wakatipu has been ascribed by Dr. Hector ("Mining in New Zealand," *Trans.* N.Z. Inst., II., p. 374) to unequal subsidence, while Mr. J. McKerrow (*Trans.* N.Z. Inst., III., p. 256*) ascribes it to the erosive action of a former glacier, in accordance with the theory put forward by my esteemed friend and instructor Professor Ramsay, which theory he has, in my opinion, reduced to a demonstration such as is rarely seen in geological inquiries. I need therefore scarcely say that I agree with Mr. McKerrow as to the glacier origin of Lake Wakatipu, but in order to establish my opinion I will examine what would be the results that an acceptance of the unequal subsidence theory would lead us to.

Lake Wakatipu is a rock-bound basin, lying in a nearly north and south direction, with a sharp east and west deflection in the middle; consequently, if it has been formed by unequal subsidence, this subsidence must have been most in a northerly direction, for if it had been in a westerly direction the end of the lake would have been at Queenstown. Of course, a southerly elevation would produce the same effect as a northerly depression. Now the deepest part of Lake Wakatipu is 1,400 feet, off Collins Bay, about 16 miles north of Kingston (McKerrow, l.c., p. 254), consequently, to change a horizontal surface to one having this slope, Kingston must have been elevated 1,400 feet more than Collins Bay, and this would give an elevation to the coast of Southland of 8,400 feet, and to Stewart Island an elevation of about 11,000 feet; or, if the lake was caused by depression, Collins Bay must have been depressed 1,400 feet more than Kingston, which would give a depression to Jackson Bay on the west coast, due north of Kingston, of 9,800 feet. These are the very least movements that can account for the phenomena, for if Kingston was not the axis of the movements, or if the movements had taken place in any other direction than that of the length of the lake, they would have to be immensely increased in order to bring about the same result. But most of the sounds, the origin of which Dr. Hector also ascribes to the same movements, are south of Lake Wakatipu, and are therefore situated in that part which would have undergone the least depression, so that they are just where they ought not to be if this unequal depression has occurred over the whole country. Lake Monowai also requires that the depression should have been towards the south instead of the north. If also movements on such an extensive scale had taken place since the pleistocene period, the river system of Otago would be certain

* In this paper Mr. McKerrow points out, I believe for the first time, the very important fact that the constrained flexure of a solid body like ice, when passing from one angle of inclination to another, would greatly increase the friction at this particular point.

to show evidence of it by some, at least, of the rivers being deflected to the north; but the very contrary is the case, for the Jacobs River, Oreti, and Mataura have all been deflected towards the south. The evidence, indeed, of the river system goes to show that the central part of the South Island has been more elevated than the southern part, a movement which must have tended to empty Lake Wakatipu.

The next supposition that we can make is that this unequal elevation and depression was not universal but local, the country north of Lake Wakatipu having alone been depressed. If, however, this local depression occurred between the head of the lake and the west coast it would have emptied Lakes Wanaka and Hawea which lie north of it; and if the depression was north of Lake Wanaka it would have emptied, in the same way, Lakes Pukaki and Tekapo, which are further north again, for all these lakes lie in a more or less north and south direction, with the south end dammed up. There appears, however (Hochstetter's "New Zealand," p. 481), to be one place, off Cliffy Head, from which many of these lakes radiate, so that if the depression had taken place there it might perhaps have formed them all. But if we assume this, we again encounter those difficulties that I at first pointed out; for by this theory the central part of the Island must have been depressed at least 15,000 feet more than the north and south, and the deep sounds instead of being found on the south-west of Otago and the north of Marlborough, should occur in Canterbury, and the rivers should be deflected to the north in Otago, and to the south in Nelson and Marlborough; for the fact of all the rivers on the Canterbury plains having cut deep gorges through the alluvial deposits, shows clearly that their velocities have not been reduced by a greater sinking of the west than of the east coast. The Nelson lakes, moreover, would require some different arrangement again to account for them.

We may still make a third supposition as to the formation of Lake Wakatipu by supposing it to be owing to a small local subsidence in that area alone, but this is disproved by the regularity of the strike of the rocks from one end of the lake to the other, and the dip of the beds is so slight that any movement by which the upper or central portion of the lake had been depressed could not possibly escape detection, and I had this constantly in my mind when examining the district last summer.

In order, therefore, to explain the formation of these lakes by unequal subsidence, and at the same time to account for other phenomena observed round the coast, we should have to imagine such a complicated system of local depressions and upheavals that they would more resemble the contortions produced by lateral pressure than any movements that we know, or have any right to assume, are going on at the surface of the earth.

In the section given by Dr. Hector (*Trans.* N.Z. Inst., II., p. 372) we see

that there are two other rocky barriers below the one at Kingston, and that each of these barriers is capped by morainic accumulations. Now, by Professor Ramsay's theory of the glaciers having excavated the lake basins, this is just what we might expect; but on the subsidence theory we have to account for these three moraines having all been deposited exactly at the places where the former glacier having got over the flatter ground was just commencing to descend a steeper slope.

These are the reasons which lead me to think that Lake Wakatipu was scooped out by a glacier, and that it cannot possibly have been caused by unequal depression; indeed, if Professor Ramsay's theory was in want of further evidence to prove it, I know of no place equal to the province of Otago for obtaining that evidence, for the rocks there have been so little disturbed that recent elevations and depressions could be generally proved or disproved.

Art. LVII.—*Notes on Miramar Peninsula, Wellington Harbour.*

By J. C. Crawford, F.G.S.

(With Illustration.)

[*Read before the Wellington Philosophical Society, 25th September,* 1872.]

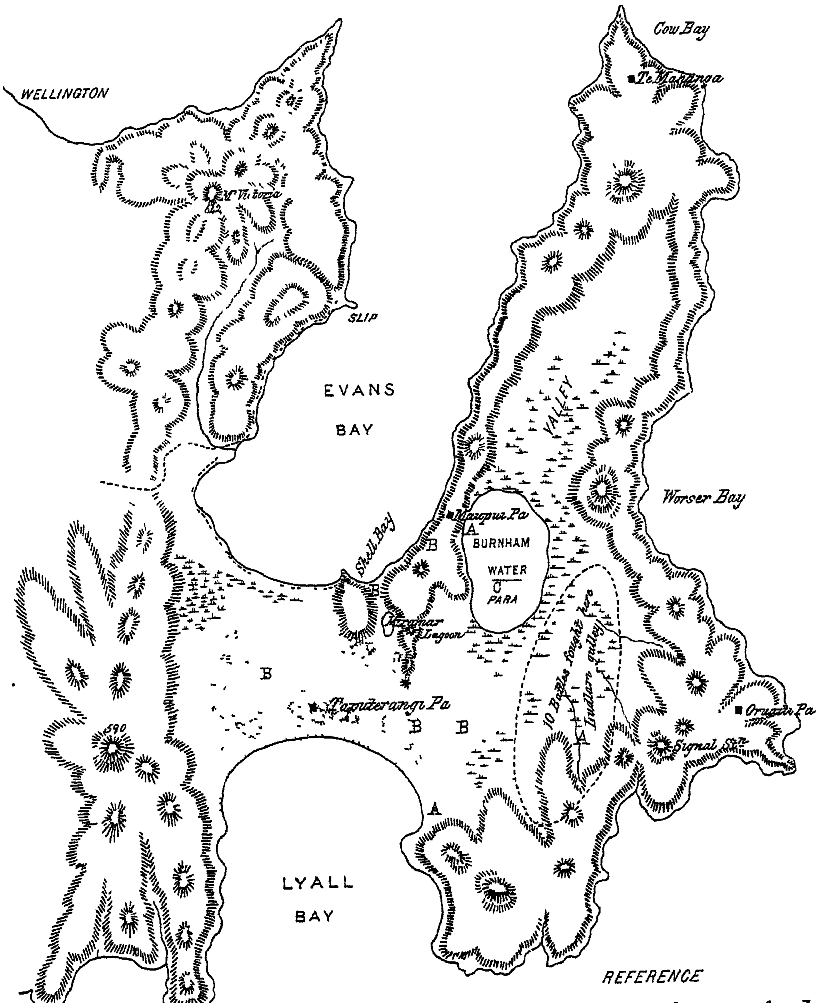
As a preliminary I propose to change the name of the peninsula at the entrance of Port Nicholson to "The Miramar Peninsula." (Pl. XXI.) The name of Watt Peninsula is neither euphonious nor appropriate. Mr. James Watt had no other connection with the land in question than the fact that he landed a cargo of cattle upon it. The name of "Miramar," or "Behold the sea," is appropriate and suitable to the locality.

The peninsula proper contains an area of about four square miles, and with the isthmus connecting it with the western side of Evans Bay contains numerous remains of ancient occupation.

The fundamental rocks consist of sandstones and slates, standing at an inclination approaching the vertical, with a northerly and southerly strike. In the centre lies a valley of denudation, open to the southward, containing nearly 700 acres, and bounded on all sides except the south by the above-named sandstones and slates.

This valley is of considerable interest both geologically and archæologically.

It is remarkably flat, making the drainage of it a matter of extension over every area. That the whole of this flat was at a late geological period covered by the sea is very evident, probably at the time when the sea stood at about fifteen feet above the present level, as evidenced by water-worn caves, the borings of *Pholadæ*, etc.



REFERENCE

A. Places where Moa bones were found

B. Maori Ovens, (Umu).

C

PLAN OF THE

MIRAMAR PENINSULA.

J B del. et lith.

The appearance of the gravel-bars shows that the sea ran in upon a shallow surface at high tide, as at Napier, and after filling the interior area ran out again at low tide, probably then leaving the bar dry. Three gravel-bars are very distinct; the chief one faces Lyall Bay, another lies towards the northern end of the old bed of Burnham Water, and the most northern is found at the narrow neck of the upper valley.

The stratification of the flat, as far as can be observed, is a basis of gravel; next a stratum of sand and gravel, containing marine shells of the following species, the names of which have been determined for me by Capt. Hutton:—

Fusus zealandicus, F. linea, Buccinum maculatum, B. testudineum, Purpura scobina, Ancillaria australis, Natica zealandica, Struthiolaria nodulosa, Turritella rosea, Cladopoda zealandica, Calyptræa maculata, Rotella zealandica, Polydonta tiarata, Labio zealandicus, Diloma nigerrima, Cantharides elegans, Nacella radians, Siphonaria denticulata, Myodora striata, Mactra discors, Mesodesma cuneata, Chione yatei, C. costata, C. stutchburyi, C. dieffenbachii, C. mesodesma, C. gibbosa, sp. nov. Ms., *Dosinia subrosea, Tapes intermedia, Mytilus smaragdinus, M. dunkeri, Ostrea purpurea.*

On or within this stratum pumice-stone is found in considerable quantity, and also remains of the moa.

The shells and pumice may be said to lie at the height of five or six feet above high water-mark. Above this, over several hundred acres, are considerable accumulations of vegetable remains, consisting of peat several feet in thickness, containing roots, stems, and branches of trees.

In Ludlam gully, on the eastern side of the flat, a formation of an apparently older date is found inclined at a high angle, containing a stratum of old soil or semi-lignite.

Several travelled boulders of granite and of schist, whose nearest locality *in situ* must be the mountains of Tasman Gulf, have been found on the bed of Burnham Water, and in other localities where they are unlikely to have been brought by canoes. Excluding the action of floating ice we must suppose that they were carried either by sea-weed or imbedded in the roots of trees.

Pumice, which is deposited in considerable quantity, was no doubt floated down from the Wanganui river, and carried inside the bars when the land was at a lower level.

The remains of old habitation on the Miramar Peninsula are numerous, and of considerable interest. Many of the kitchen-middens appear to be of ancient date, as they have been covered by drift sand and afterwards by vegetation, and have now again been uncovered. Their localities, with those on the isthmus, can be seen by a reference to Pl. XXI.

In the year 1840, when the first European settlers landed on the shores of Port Nicholson, the hills of the peninsula were chiefly clothed with the

common fern mixed with *Phormium tenax*, koromiko, tutu, ti, etc. A few patches of bush filled some of the gullies, but in general the forest had been destroyed.

The flat may be said to have been chiefly occupied by water. A shallow lake, called by Colonel Wakefield Burnham Water, spread over about 200 acres of the central area, and the water from it extended up the large swamps both to north and south, lying in general nearly flush with the surface of the swamps. These swamps were composed of a mass of vegetation, of from four to seven feet thick, while in a wet state, lying upon the sand or gravel, the plants consisting of flax (*Phormium tenax*) rushes, raupo, etc. In the northern swamp a flax stick could in any part be easily pushed down to a depth of six or seven feet before it struck upon the hard sand.

The depasturing of cattle and sheep, with a considerable surface-sowing of English grasses, has had the effect of almost entirely destroying the common fern on the hills, and replacing it with a close sward of a considerable variety of English grasses, mixed with a proportion of those indigenous to the country.

Finding it impossible to keep open an outlet into Lyall Bay for the drainage of the flat ground, I determined to drive a tunnel from Evans Bay through the narrow ridge which separates that bay from Burnham Water. This work was first executed in the year 1849, and was subsequently enlarged and further extensive drainage works carried on in the year 1859. The result has been that the water-level has been lowered about six feet, that the swamps have solidified, and the former vegetation which covered them has been replaced by a sward of English grasses, and that the former bed of Burnham Water is being rapidly covered with grass.

The following information relative to the peninsula was furnished to Mr. Wardell, R.M., by Te Manihera, of Wairarapa, and translated by Mr. Joseph Freeth :—

"The greater portion of the peninsula was formerly occupied by Rangitane, but at what date the occupation commenced is not known. The history commences from Te Rerewa (a Rangitane) who it is supposed erected the pa called Oruaite. The principal chiefs who occupied the pa were Te Rerewa, Te Huataki, Rangitahatiti, and Tukanae. After the great cession of lands by Te Rerewa to Ngatikahungunu the Rangitanes crossed over to the other island (Aropaoa). The Oruaite pa was then occupied by Ngatikahukura-awhitia, a hapu of Ngatikahungunu, and by Ngatihakeke, the principal chief being Kaingakiore. During his time war was carried on against Ngatika-hungunu by Ngatiapa and Wanganui. Ten battles were fought in the vicinity of Oruaite as marked on the map. While the tenth battle was raging Kaingakiore consulted with his chiefs as to the desirability of going outside the pa and fighting the enemy on the open ground. His chiefs and his son did

not approve of such a course, but after some time he could not be restrained, and yelling out, 'Tukua te kiore a Rakaimahiti; kia tete, tete ki waho!' (Let go the rat of Rakaimahiti; if there is to be a struggle let it take place outside), he rushed out, followed by the main body of his warriors.

"A most desparate conflict ensued, in which the enemy were driven back and retreated to the gully, marked on the map as 'Ludlam Gully,' where they again rallied and made a desperate resistance, during which Kaingakiore was killed, but nevertheless his people were victorious.

"During this engagement Ngatiapa and Wanganui lost 500 (make a liberal allowance for the exaggeration of the partisan narrator) killed, and Kaingakiore 70. After this a great number of Ngatikahukuraawhitia and other Ngatikahungunu hapus occupied most of the peninsula, and the other pa, marked on the map as 'Maupuia,' was erected and occupied by Ngatihinepari. The name of the chief was Te Rahui. No battles of any importance took place at Maupuia, although several did take place at various places in the neighbourhood of Wellington, one at Kokotahi, another at Te Taniwha, in which Ngatiapa were beaten.

"Te Mahanga (near Cow Bay) was not a fortified pa, but a taupahi, *i.e.*, a very large native village, which was occupied by the same hapus as the pas. A large pa was erected on the isthmus and was named Taputeranga, but at what time it was erected I could not ascertain.

"For a long time after the battles above-mentioned there was no fighting beyond a few skirmishes. After seven (?) generations most of the people left the peninsula of their own accord, and went to their other possessions elsewhere, leaving behind them a hapu called Ngatipuku to retain possession. After a while Ngatitoa came to take possession. They were led by Te Rauparaha. When Ngatikahungunu came to hear of this, they attacked Ngatitoa, who fled to Kapiti and other places. Te Rauparaha then sent for Waikato, Ngatimaniapoto, Ngatiraukawa, Ngatiawa, and Ngapuhi, who when they came took possession. They were well armed with guns, but were attacked by Ngatikahungunu (who had native weapons only) and beaten; some escaped to Wharekauri and other places.

"After this, all the chiefs of Ngatikahungunu held a great meeting, at which it was decided that they would give up fighting for a time, and disperse to every place where they were likely to be able to obtain guns and ammunition from the Europeans. Te Kekerengu, the principal chief, said he and his followers would go to the other Island and obtain what guns they could. He went with 108 followers. Taiaroa (father of the present member of Parliament of that name) was the principal chief of Ngaitahu at that time. On the arrival of Te Kekerengu and his friends they were murdered by Ngaitahu, only one escaping. This was done without the knowledge or consent of

Taiaroa. This murder was the cause of great grief to Ngatikahungunu, and they were so enraged that they all combined to take revenge upon Ngaitahu. They commenced carving canoes without number, they collected all the dressed flax and pigs and every other thing which they could dispose of to the Europeans in exchange for guns and ammunition, determined that when they had got a sufficient supply they would go and utterly annihilate Ngaitahu. In the meantime Te Rauparaha heard of the murder, and although he was an enemy of Te Kekerengu he was so indignant at such treachery that he went and fought with Ngaitahu and beat them ; but in his battles with them he suffered severely, losing most of his principal chiefs.

"Shortly afterwards Ngatikahungunu began to assemble, and when they arrived at Ahuriri they were 1,000 strong, and so well had they carried out their arrangements that most of them had from two to three guns each! However, when they reached Ahuriri, they found that a missionary had arrived there. The missionary made every endeavour to dissuade them from their purpose, and so far did he succeed that they agreed that only those men who were actual owners of the land (peninsula) would go to the fight; but even this was not carried out, for in consequence of the influence of the missionaries they did not go over to Ngaitahu. There were, however, a few battles or skirmishes between them and the Ngatiawa, and the other tribes who had come to the assistance of Te Rauparaha, in one of which a woman named Ripeku, daughter of Te Wharepouri, was taken prisoner by Nuku, a fighting chief of Ngatikahungunu. He told her that she should not be killed, but that she must return to her father and tell him that he must go up to Nukutaurua and see Nuku, and make peace with him. She returned, and when Te Wharepouri was told what Nuku had said he immediately started for Nukutaurua, but when he arrived he found that Nuku had been drowned some time. However, Nuku's people so far respected the wishes of their former chief as to make peace with Te Wharepouri and the others, and thus the Ngatiawa were left in quiet possession of the peninsula, as the Ngatikahungunu did not desire to return to it.

"Some of the timber used in the construction of the pas was got on the peninsula, some from the Hutt. There was at that time a little rimu and totara, with a good deal of tawai, etc., on the eastern or Worser Bay side of the peninsula."

It is much to be desired that a record of the native history of other localities should be obtained before the traditions have passed away from the recollection of the Maoris. I therefore trust that the example which I have now set may be followed.

For the description of the botany of the peninsula I am indebted to Mr. J. Buchanan (see Art. XLVI).

PROCEEDINGS.

WELLINGTON PHILOSOPHICAL SOCIETY.

FIFTH ANNUAL GENERAL MEETING. *29th January*, 1872.

W. T. L. Travers, F.L.S., President, in the chair.

ABSTRACT REPORT OF THE COUNCIL.

DURING the past year nine general meetings have been held, at which forty-two original papers on various subjects were read, all of which have been forwarded to the Governors of the New Zealand Institute for publication in the fourth volume of the *Transactions*. Amongst the authors of these papers will be found the names of seven new contributors, indicating the increasing interest taken in the labours of the Society.

The balance sheet shows that the actual receipts for the past year, including balance from previous account, amounted to £138 1s. 7d., and the expenditure to £40 2s. 1d., leaving a balance in hand, exclusive of any arrears of subscriptions, of £97 19s. 6d. The subscriptions of fifty members are in arrear, but will probably be soon collected. Twenty new members have joined the Society, making the number at present 126.

The Chairman stated that an appropriation of £28 would shortly be made for the purchase of the Reports of the Geological Society from its commencement to within the last year or two.

ELECTION OF OFFICERS FOR 1872: *President*—James Hector, M.D., F.R.S.; *Vice-Presidents*—J. C. Crawford, F.G.S., John Kebbell; *Council*—Captain F. W. Hutton, F.G.S., Charles Knight, F.R.C.S., W. T. L. Travers, F.L.S., John Buchanan, H. F. Logan; *Hon. Treasurer*—F. M. Ollivier; *Hon. Secretary*—R. B. Gore.

1. A letter received from the Smithsonian Institute was read regarding certain publications presented to the Society.

2. Observations on *Naultinus pacificus*, Gray," by F. J. Knox, L.R.C.S.E. (See *Transactions*, p. 307.)

Mr. Travers suggested that lizards cast their tails in the same manner that crabs could cast off a wounded limb.

SECOND MEETING. *20th July*, 1872.

Dr. Hector, F.R.S., President, in the chair.

New members.—Commander R. A. Edwin, R.N., C. J. Harrison, J. Carruthers, C.E., Alfred Dobson, C.E., George Park, Hon. Capt. Fraser, F.R.G.S., C. J. Nairn.

Publications received since last meeting were laid on the table.

1. "Preliminary Notes on Mr. H. H. Travers' Recent Collections of Plants from the Chatham Islands," by Baron Ferd. von Mueller, C.M.G., M.D., F.R.S., Hon. Mem. N.Z. Inst. (See *Transactions*, p. 309.)

The author considers that we have now an almost complete knowledge of the flora of these islands.

Mr. W. T. L. Travers stated that, besides the botanical collection, his son had made large ethnological and zoological collections, and that the results of his expedition would be brought before the Society during this season. He believed they would throw much light on the habits of the Moriori race.

The President said he had been fortunate enough to secure Mr. Travers' collections for the Colonial Museum, and that they would be valuable for exchanges with European museums. He was glad to find that the botanical collections were so highly appreciated, and he trusted that they would enable botanists to make accurate deductions respecting the geographic range of the species found there, as Baron von Mueller is to communicate a complete essay on the plants to the Society.

Mr. Travers explained that the reason why the collection had not been intrusted to Mr. Kirk, of Auckland, for description was, that the collection of a former expedition, the expense of which was borne by himself, was described by Baron von Mueller, and published at the cost of the Victorian Government.

2. "Notes on some of the New Zealand Birds," by James Morton, communicated by Captain Hutton. (See *Transactions*, p. 225.)

Captain Hutton stated he did not agree with some portions of the author's observations. However, if the description given of a blue crane with a dorsal crest is correct, it must apply to a species that has not yet been described.

3. The following natural history notes by W. Buller, Sc. D., F.L.S., F.G.S., were read. Remarking on Capt. Hutton's paper on "The Lizards of New Zealand,"* the author stated :—

"*Naultinus elegans.*

"Captain Hutton remarks (p. 171), "The figure of *N. elegans* in the *Transactions* of the New Zealand Institute, III., p. 4, is not that species, but *N. punctatus.*"

* See *Trans.* N.Z. Inst., Vol. IV., p. 167.

Dr. Günther says that *N. elegans* and *N. punctatus* are one and the same species.

"*Norbea isolata.*

"I fear Captain Hutton is wrong in referring his new species to the genus *Norbea.* Dr. Günther is of the same opinion, and considers the existence of such a form in New Zealand as improbable as the occurrence there of a crocodile!

"The 'depression on the top of the head' may be a mere abnormity of character, for this is very common among the lizards.

"*Naultinus sulphureus.*

"There are two specimens of my *N. sulphureus* in the British Museum, one of them presented by Dr. Sinclair, the other by Capt. Byron Drury, R.N.

"I think Capt. Hutton will find, on further inquiry, that Dr. Hector's type-specimen did come *originally* from the Hot Springs.

BIRDS.

"*H. brunnea.*

"Dr. Finsch writes me as follows:—'I consider *Hieracidea brunnea* as doubtful a species as *Nestor occidentalis*; and if you declare the very singular *Stringops greyi* a mere variety I think you ought to do the same with the two former.'

"Mr. J. H. Gurney, however, who is an acknowledged authority on *Accipitres,* writes me, under date April 10, 'I am sure you are right about the distinctness of the two New Zealand *Hieracideæ.*'

"*Nestor occidentalis* has been retained provisionally for the reasons given in my work on the Birds of New Zealand (pp. 50–51). My arguments for the reduction of *Stringops greyi* to the rank of a synonym are, I think, conclusive. Mr. G. R. Gray (who described the so-called new species) says he accepts my decision. I may add that latterly he was himself very doubtful of the validity of the species."

Captain Hutton explained with reference to *Norbea isolata,* that he thought the frequent representation in New Zealand of tropical forms was not sufficiently appreciated. The lizard in question is of a stunted form, and may be a case like some tropical plants that are found in New Zealand and other islands near hot springs.

4. Dr. Hector described a Porpoise that had been shot by Mr. Lewis Wilson, from the s.s. "Luna." The skull proves it to be *Electra clancula,* a species founded on the skull of a specimen in the British Museum. (*Vide ante,* p. 160.)

5. "The Ascent of Tauakira," by H. C. Field.

(ABSTRACT.)

Tauakira, known to sailors as "The Devil's Thumb," is an important

land-mark, rising several hundred feet higher than any other point along the northern side of Cook Strait, and when brought in line with the great snowy mountain, Ruapehu, shows the entrance to the Wanganui River.

No one had succeeded in reaching the summit till last March, when the writer and some others ascended the Wanganui River, and after some difficulty gained the top of the mountain, whence very extensive views of the surrounding country were obtained. The author states that "Dr. Hochstetter was mistaken in assuming, from its appearance when viewed from a distance, that Tauakira is of volcanic origin. It is simply a culminating peak of the recent white clay formation. Two large slips which have recently occurred on its northern face have exposed the substratum, from the hill-top right down to the Operiki gully, a depth of fully a thousand feet, and nothing but the white clay is visible anywhere along it. The crest of the hill, like that of nearly all the others of the same formation, is very narrow, and has its northern face precipitous, while sloping gently towards the south.

"The party had with them no means of measuring the height of the hill, but by vertical angle from the town of Wanganui it appears to be about 2,400 feet, and this agrees so nearly with the comparative heights, 1,883 feet and 1,890 feet, assigned to Taupiri, that there is little doubt as to its being almost if not quite correct. The bearings from Tauakira confirmed the accuracy of others which had been previously taken, and proved conclusively that Ranana, which is always reckoned 60 miles from the town of Wanganui by the river, is actually only 21¼ miles in a straight line from the Wanganui Heads."

Among the exhibits on the table was a collection of stone weapons found on the south bank of the Teremakau by Judge Harvey. Besides green-stone and horn-stone adzes, there was a large mass of chert for making cutting flakes.

Some bones recently obtained by the Hon. Captain Fraser in the same cave in Otago where the Moa's neck was obtained, were shown.*

The President stated that some of these bones, which are very fresh, belonged to the *Cnemiornis*, and with those is a *humerus* or wing bone of large size, which differs from the wing bone of that bird, as described by Professor Owen, in possessing a pneumatic foramen, which is generally considered to indicate a bird of flight. There are also the bones of a very large weka, which must have been equal in size to the large kiwi, and the bones of paradise ducks. Dr. Hector hoped that the remarkable deposit in this cave would soon be carefully explored.

A sample of sheeting made from New Zealand flax (*Phormium*) forwarded by Dr. Featherston was exhibited. Also portions that had been tested for strength and lasting power with soap and bleaching powder by Mr. Skey, and found to wear well.

---

* *Vide ante*, p. 102.

At the close of the meeting Mr. T. Kelly, M.H.R., exhibited and explained to a number of the members interested in such matters a full-sized model of a new flax-dressing machine. The novelties in the construction were highly approved by those competent to judge of such matters.

THIRD MEETING. 14*th August*, 1872.

Dr. Hector, F.R.S., President, in the chair.

New members.—Adino Boughton, Lipman Levy, Charles Nichol.

Presentations to the Society, and additions to the Museum were laid on the table. Among these were specimens in a crude and prepared state of the iron paint manufactured from hematite ore, lately discovered near Collingwood; also, a specimen of soap-stone, which has been found in large quantities in the same locality, and will be extremely valuable as a fire-stone for the construction of furnaces; and lastly a splendid sample of tobacco, grown, cured, and packed by the King natives at Tokangamutu, contributed by the Hon. D. McLean.

The President then delivered the following

ADDRESS.

GENTLEMEN,—

It is the usual custom for the President of this Society to address the members at an early period during the session for which he is elected. I will on the present occasion conform to the custom by selecting a few subjects for comment which relate either to the past Transactions of the Institute or to collateral scientific work which has been done in the colony during the last few years, and which, I think, may be reviewed with profit.

I wish, in the first place, to allude to one section of our published *Transactions* to which only very short notice has been devoted in previous addresses from this chair, as some of the results are important from a practical point of view. I allude to the communications on chemical subjects, which, with one exception, have all been made by Mr. Skey, the Analyst to the Geological Survey Department.

I am aware that such papers are not very attractive to the general reader, nor can they be expected to excite much interest or discussion at our meetings; but it must be remembered that the statements advanced in chemical papers are not mere opinions or theories, but describe actual experimental observations which are open to the test of verification by other chemists in their own laboratories.

One of the subjects of most general interest on which Mr. Skey has written disproves the view generally held that gold is unaffected by sulphur or sulphuretted hydrogen gas, and shows on the other hand that these elements combine with avidity, and that the gold thus treated resists amalgamation with mercury, a most important fact, which, it will be remembered, was strikingly illustrated by experiment after one of our meetings. The author has also proved this act of absorption of sulphur by gold to be a chemical act, as he has shown that electricity is generated in sufficient quantity and intensity during the process to decompose metallic solutions. He thinks further that much native gold is thus sulphurized, and that this circumstance is the greatest obstacle to its thorough amalgamation in ordinary quartz mills.

Mr. Skey was led to this interesting observation while investigating the causes of the loss of gold experienced in the Thames district, and the object of his inquiry must be held to have been satisfactorily accomplished by the discovery of this important fact.

He was aware that sulphur in certain forms has long been known to exercise a prejudical effect upon the amalgamation of gold, but this has always been attributed to the combination of the sulphur with the quicksilver used; now, however, it is certain that the sulphurizing of the gold itself must be taken into account. So long as our chemical books described gold as being unaffected by sulphuretted hydrogen it appeared as if in the ordinary amalgamating process we had nothing to fear from this gas, except its effect upon the mercury, but now that it is proved that gold itself is also readily attacked by this compound we must take the circumstance also into account that the particles of gold in the stone may be enveloped with a film of auriferous sulphide, by which they are protected from the solvent action of the mercury.

The merit of this discovery, from an experimental point of view, is that the sulphurization of the gold gives no ocular manifestation by change of colour or perceptible increase of weight, as in the case of the formation of sulphides of silver, lead, and other metals, on account of the extremely superficial action of the sulphur, and hence probably the existence of the gold-sulphide hitherto escaped detection by chemists.

Closely allied to this subject is the investigation of the mode in which certain metals are reduced from their solutions by metallic sulphides, or, in common language, the influence which the presence of such substances as mundic and galena may exercise in effecting the deposit of pure metals such as gold in mineral lodes. As this investigation has a very direct bearing on the discussions relative to the origin of large gold nuggets and the heavy masses of gold that are sometimes found in reefs formed by hydrothermic agencies, I will take this opportunity of stating the position of the question.

The close relation which the richness of gold veins bears to the prevalence

of pyrites has been long familiar both to scientific observers and practical miners, and I remember in 1860 specimens of quartz were given to me in California having cavities left by the decomposition of cubic pyrites, and which contained only a brown powder of oxide of iron and thin films of gold, as showing that the pyrites and not the quartz was the true matrix of gold.

This view, however, has not proved to be the correct one, the gold having been shown to be an after deposit to the pyrites, and, as Mr. Skey has been the first to explain, due to its direct reducing influence. It appears that in the first place my friend Mr. Daintree, who is now Agent-General for the Colony of Queensland, at the time he was on the geological survey staff of Victoria, pointed out that a nucleus of gold, when placed in a solution of chloride of gold undergoing decomposition by organic matter, is increased in bulk by a deposit of pure gold. Following up this hint, Mr. Wilkinson, also a Victorian chemist, found that many other substances, chiefly metallic sulphides, would also act as nuclei, but that quartz does not do so; and Mr. Cosmo Newbury afterwards indorsed the correctness of these results. In this state of the question Mr. Skey took up the subject, and by a series of experiments, which are detailed in our *Transactions*, proved that the organic matter is not at all necessary to produce the reduction of the metal, but that it is due to the direct action of the sulphide, and showed that each grain of iron pyrites, when thoroughly oxidised, will reduce $12\frac{1}{4}$ grains of gold from its solution as chloride, which is a proportion far beyond that which could be effected by the same weight of organic matter. He also included salts of platina and silver in this general law, and demonstrated that solutions of any of these metals traversing a vein rock containing certain sulphides would be decomposed and the pure metal deposited.

We are thus enabled to comprehend the constant association of gold, or native alloys of gold and silver, in veins which traverse rocks containing an abundance of pyrites, whether they have been formed as the result of either sub-aqueous volcanic outbursts or by the metamorphism of the deeper-seated strata which compose the superficial crust of the earth.

Still following the same line of induction, Mr. Skey has also shown by very carefully conducted experiments that the metallic sulphides are not only better conductors of electricity than has hitherto been supposed, but that when paired they are capable of exhibiting strong electro-motive power. Thus, if galena and zinc-blende in acid solutions be connected in the usual manner of a voltaic pair, sulphuretted hydrogen is evolved from the surface of the former, and a current generated which is sufficient to reduce gold, silver, or copper from their solutions in coherent electro-plate films.

By pairing the different metallic sulphides Mr. Skey was further able to construct a table of their relative value as electro-motors and conductors

of electricity, the latter of which, a comparative quality, he suggests might be usefully employed as a preliminary test in the analysis of mixed minerals.

The attributing of this property of generating voltaic currents, hitherto supposed to be almost peculiar to metals, to such sulphides as are commonly found in metalliferous veins, further led Mr. Skey to speculate how far the currents discovered to exist in such veins by Mr. E. Fox some forty years ago might be produced by the gradual oxidation of mixed sulphides, and that veins containing bands of different metallic sulphides, bounded by containing walls and saturated with mineral waters, may constitute under some circumstances a large voltaic battery competent to produce electro depositions of metals, and that the order of the deposit of these mineral lodes will be found to bear a definite relation to the order in which the sulphides rank in the table of their electro-motive power.

It is quite unnecessary for me to point out that these researches have a most practical bearing on our knowledge of the conditions under which precious metals will be found, and when applied by geologists may yet lead to some clearer comprehension than we at present possess of the law which regulates the distribution of auriferous veins, and why in some cases the metal should be nearly pure, while in others it is so largely alloyed with silver.

There are many other subjects, to which I cannot at present refer, on which Mr. Skey has advanced our knowledge, such as the investigation of the poisonous matter of the tutu, karaka, and other indigenous plants, the formation of coal seams, and other matters of interest.

As being a subject of general interest at the present time, in the discussion of which many of our members who have not much taste for technical science can take part, I wish now to refer to the state of opinion relative to what we must term the pre-historic period of New Zealand.

A most complete summary of the views on this subject prevalent a few years ago is given in Professor Hochstetter's valuable work on this colony, in which he adopted the conclusion that the Maoris first arrived in New Zealand about 500 years since, and gradually spread over the country, altering the surface features considerably, and, for instance, among other changes effected the extermination of the Moa, which, from the authorities he quotes, he supposes to have survived to about the middle of the seventeenth century.

I do not feel competent to judge of the extent to which Mr. J. T. Thomson's paper in the last volume of the *Transactions* modifies the previous opinions held respecting the origin and migration of the Maori race,* but his paper, and also the critical paper by Mr. Travers,† on the value of native traditions as evidence, appear to indicate that the subject is still open to discussion, and I am glad to learn that during our meetings this season we may expect several communi-

* See *Trans.* N.Z. Inst., Vol. IV., Art. I. † Vol. IV., Art. II. 1

cations from Mr. Travers and other members relative to the early history of the Maoris, and what will have even greater interest, the traditions that have been preserved by the small remnant of the Moriori race that now survives in the Chatham Islands.

There is one branch of investigation relative to the native race to the importance of which I venture to invite the attention of medical men in this colony who have opportunities for collecting such information, and that is the nature and especially the early history of the diseases that are peculiar to the natives, and to which they were subject before the arrival of Europeans. I will only instance as an example one disease, respecting which it is desirable that full information should be obtained, and that is leprosy, as from remarks that lately appeared in the newspapers relative to the occurrence of leprosy in the Sandwich Islands, I infer that it is not generally known that there is a form of this disease amongst the Maoris, although it is mentioned by Mr. Colenso and other writers. I have myself seen eight or ten cases in the interior of this Island, and I observe that during a recent visit to Stewart Island, Professor McGregor found two well marked cases even in that comparatively ungenial climate. The unfortunate victims of this disease were, I believe, in former times kept carefully secluded, but I fear that this provision for preventing the spread of the disease, like many other old customs of the natives, is now less rigidly enforced. In the case of the Maoris it is usually supposed that it can be traced to the use of improper food, but, whatever be the cause, experience in other countries where this insidious disease prevails dictates that proper seclusion of the sufferers should be maintained.

Leaving to others the discussion of purely historical and traditional matters affecting the Maoris, I shall advert to the period at which the gigantic Moa birds were exterminated, and the circumstances that led to their destruction. Communications relative to this subject occupy a very large share of the last volume of our *Transactions*, and conflicting opinions are expressed which deserve a brief notice.

This question has an important bearing on many inquiries that should occupy our attention in New Zealand. You are all well aware that this country possesses an indigenous fauna and flora that is peculiar to these islands. The period at which it first acquired this insular character is a most interesting subject for investigation by the geologist, and the period of the first interruption of that isolation from other zoological and botanical regions which must have been effected by the introduction of the human race is not less important in its relation to the diffusion and persistence of types of animals and plants.

The destruction of the Moa must have been one of the most obvious and direct results of this, accompanied no doubt by extensive alteration in the

flora of the country by the rapid spread of fires. It is true that fires probably originated in some districts in the North Island from volcanic eruptions, and that the large open tracts in the vicinity of Taupo where there are pumice drifts, containing charred wood, are probably of an earlier date than the first arrival of the Maori race, but in the South Island there are no recent volcanos to account for the spread of fires, and there is no other cause to which the conversion of what has evidently been within a modern period forest land, first into scrub and finally into grass land, can be attributed, except artificial fires.

The co-existence of man with the Moa, and the fact that these gigantic birds were hunted and consumed as food, was long ago recognized, in the first instance I believe by Mr. Mantell, but the question of whether it was by the ancestors of the Maori race now inhabiting these islands was never distinctly raised till last year, when Dr. Haast did so in the first of the series of papers on the subject to which I have referred.

In this communication Dr. Haast, led by his extensive researches and the study of a magnificent collection of Moa bones, and of the ancient native cooking-places, which are plentiful on the east coast of the province of Canterbury, adopts the view that the extinction of the Moa was effected by a race of men altogether distinct from the Maoris, who belonged to the palæolithic period, and had passed away long before the Maori settled here.

The evidence upon which this hypothesis is based is of two kinds. First the nature of the implements that were used by the early Moa-hunters, as Dr. Haast terms them, and secondly the supposed ignorance either direct or traditionary, which the Maoris display of the former existence of the Moa. There are other arguments brought forward, but as they are not so direct in their bearing on the question I will not allude to them on the present occasion. The description given of the cooking-places in which Moa bones have been found by Mr. Mantell, Dr. Haast, and other observers, does not indicate any difference in the habits of the Moa-hunters from the ordinary mode of life of the Maoris even at the present day; the only supposed peculiarity being the occurrence in the ovens of rough stone flakes with cutting edges instead of the polished implements of stone which we are accustomed to see now in the hands of the natives.

It is hardly necessary to point out, as has been already done repeatedly, that evidence of this kind cannot be considered to establish a difference of race, for the uses to which the two kinds of stone implements could be applied must have been totally different. It has never been alleged that before the time of Captain Cook's visit the natives were in possession of any cutting instruments made of metal; and yet as they ate seals, porpoises, and other fleshy animals, they must have had some means of cutting them up, and for

this sharp-edged flakes of stone would be best adapted. I am inclined to think that the old Maori woman who officiated as cook at one of the Moa-hunters' encampments would have found it a most trying task to dismember a Moa with a polished stone adze or a green-stone mere, even if she would profane so valued an implement for such a purpose; and I also think that unless the meat were very much overcooked the hungry Moa-hunters, however large their stock in trade of polished weapons might be, would prefer to pick up a sharp-edged stone to assist them in cutting slices from the ponderous drum sticks. The fact is that the adzes and other polished tools were no doubt then, as they are now, used as implements for tilling the soil and grubbing up fern root, and when occasion required, for felling a tree or a foe, and that for cutting up a pig or flaying a seal, a Maori, if he had no knife, would at the present day use sharp stone flakes, of which there are abundance about all Maori cooking-places, especially on the sea coast, where their services are most required. I may mention as a further confirmation of this view that among a very interesting collection recently brought by Mr. Henry Travers from the Chatham Islands, where no Moa bones have ever been found, there are many of these flakes, together with stone implements of all kinds, rude and polished, specimens of which are on the table for your inspection.

The other evidence advanced by Dr. Haast respecting the absence of any traditions among the Maoris of the existence of this remarkable bird within the memory of the race is merely negative, and against which contrary evidence can be advanced. Dr. Haast quotes Mr. Colenso, who was well acquainted with the Maoris at the time when the former existence of the Moa first became known to Europeans, and who admits that they had a certain amount of indefinite information concerning the existence[*] of large birds like the Moa prior to that date, but attributes it to the traditions of the cassowary, which they had preserved from the time of their original migration from Hawaiki. Dr. Haast also suggests, as a further source of their knowledge, that these were the bones of a

[*] Polack, whose observations were made many years before the first discovery of Moa bones by Europeans, says:—"That a species of the Emu, or a bird of the genus *Struthio*, formerly existed in the latter (North) Island I feel well assured, as several large fossil ossifications were shown to me when I was residing in the vicinity of the East Cape, said to have been found at the base of the inland mountain of Ikorangi. The natives added that in times long past they received the tradition that very large birds had existed, but the scarcity of animal food, as well as the easy method of entrapping them, had caused their extermination." And speaking of the South Island he states:—"I feel assured, from the many reports I received from the natives, that a species of *Struthio* still exists on that interesting (South) Island, in parts which, perhaps, have never yet been trodden by man. Traditions are current among the elder natives, of Atuas, covered with hair, in the form of birds, having waylaid former native travellers among the forest wilds, vanquishing them with an overpowering strength, killing and devouring, etc."—Polack's "New Zealand," Lond., 1838, Vol. I., pp. 303, 307.

Struthious bird, and that they had no doubt, on finding these huge bones, compared them with those of the existing kiwi, and thus arrived at a correct conclusion respecting the nature of the original owners, and even determined the kind of feathers with which the bird was clothed. Such an exercise by the untutored savage of scientific skill, that among civilized nations is only acquired by great comparative anatomists, is to my mind less easy to understand than that the Maoris had at one time been familiar with the Moa in the district where the inquiries were made. So far as the subject can be enlightened by a study of the language and traditions of the natives, I am sure there can be no higher authority than Mr. Colenso, whose high scientific reputation was established at an early date in the colony by his many contributions to the natural history of the country; and I sincerely trust that he will yet find leisure from the great philological work on which he is now engaged to go fully into this matter; but there is also the evidence of his own observations to be taken into account, relative to which I will read to you the account of his earliest acquaintance with the Moa, as it was communicated by him to the "Tasmanian Journal," in 1842:—

He states that during the summer of 1838 he accompanied the Rev. W. Williams on a visit to the tribes inhabiting the East Cape district. Whilst at Waiapu, a thickly inhabited locality about 20 miles south-west from the East Cape, he heard from the natives of a certain monstrous animal, which, while some said it was a bird and others a "person," all agreed that it was called a *Moa*, that in general appearance it resembled an immense domestic cock, with the difference, however, of its possessing a face like a man;* that it dwelt in a cavern in the precipitous side of a mountain; that it lived on air, and was attended or guarded by two immense tuataras, who, Argus like, kept incessant watch while the Moa slept; and that if any one possessing temerity sufficient dared to approach the dwelling of this wonderful creature he would be infallibly killed by it—the process suggested being trampling to death—indicating, I venture to think, that they knew the habits of the bird, which were no doubt like those of the emu in its mode of attack. He further states that the belief in the Moa was universal, and to doubt it was a crime. Natives had, however, seen and described large bones, which they ascribed to the Moa, and all the natives had great fear of the bird, and belief in its prodigious physical power. On returning to the Bay of Islands, natives from the East Cape district confirmed the foregoing information.

In 1839 the Rev. Mr. Taylor,† being at the East Cape and hearing of the Moa, searched, and was rewarded by finding a gigantic toe of the bird. In 1841–42, while at Waiapu, he heard that Wakapunake had been visited by

* Mr. Mantell suggests that the phrase would be "Ahua tangata," which might be rendered "stature of a man." † *Vide ante*, p. 97.

some baptized natives, and, though they found no live Moa, they found some huge bones, which they declared to be those of the true Moa. These had been collected by the natives apparently as a matter of course, for the manufacture of fish-hooks, for he obtained such hooks.

Mr. Colenso then proceeded himself to the mountains, and made inquiries at a native village, where he was informed that the Moa still lived, though he had not been seen. The bones were, however, stated to be common. Similar inquiries in another district—Tiwhiti—also reported to be inhabited by Moas, gave the same result, the natives proving their knowledge of the bones, and that they belonged to the Moa, but without being able to afford any proof that they were justified in believing that he still lived. These inquiries stimulated the natives to search, so that in a short time the bones of nearly thirty birds, all of one gigantic species, were obtained.

After thus recounting his experiences, Mr. Colenso proceeds to infer that the above knowledge of the existence of this bird must have been merely traditionary; but I do not think this a fair deduction, because Mr. Colenso evidently hoped to be shown the live bird by the natives he employed, and though the natives could not do so, they yet had no difficulty in finding the bones for him in large numbers and in perfect preservation. It must also be remembered that the natives with whom Mr. Colenso communicated on the subject lived in a district which was the first settled by their ancestors, and that, although the Moa may there have been extinct for many generations, this is no reason why it may not even at that date have been existing in the South Island for all they knew to the contrary.

Having in a former communication on the subject referred to the interior of Otago as probably the part of New Zealand in which the Moa survived longest, and feeling anxious to discover the condition in which that district was found by the first European explorers, I applied to my friend Mr. John Buchanan, who is as distinguished for his power of accurate observation as he is for the skilfully executed lithographs which illustrate our *Transactions* and Natural History publications.

Mr. Buchanan was attached to the first surveying—I may call it exploring—party sent out by the Otago Government in 1856 into the district where the best preserved Moa remains have since been discovered, the surveyor in charge being Mr. Garvie, who was at the time in bad health, and did not long survive the hardships the party underwent.

They penetrated as far as what is now the Cromwell township, at the upper end of the Dunstan gorge, or almost seventy-five miles west from the coast in a direct line, the settled country, or rather that which had been taken up as sheep runs, not extending at the time beyond the depression between the Manguatua or Lammerlaw ranges, or a distance of twenty-five

miles back from the east coast in a direct line. The Rough Ridge, Raggedy, Rock and Pillar, and Dunstan ranges, with their intervening vallies, were prior to their visit a *terra incognita*, as far as Europeans were concerned. The upland district east of the Lammerlaw hills, between 2,000 and 4,000 ft., was at that time covered partly with coarse grass and partly with dense scrub. The grass patches had been several times burnt, much to the detriment of the country, as the finer species were giving place to the coarse tussock-grasses (*Danthonia*), spear-grass (*Aciphylla*), and other worthless pasture plants. The scrub consisted of open sub-alpines, consisting chiefly of *Veronicas* and *Celmisias*, such as still survive in most parts of these uplands. The form of the surface and the abundance of well-preserved trunks of trees in certain parts of this district showed that at no distant date it had been forest land. In this district Moa bones were remarkably abundant, the large leg bones lying strewn on the surface in great profusion and in very perfect preservation, most of them being quite hard, except when they had been roasted by the later grass fires. At the same time, Mr. Buchanan remembers that much fresher bones had been found near the coast, and that it was well known to some of the old settlers at Green Island, near Dunedin, that the dogs used to be seen gnawing the Moa bones, which we must therefore presume contained some nutritious juices. This is a very important statement, because it has been urged that the superior state of preservation in which the Dunstan Moa remains have been recently found is due to the extreme dryness of the climate of the interior of Otago. But this argument is quite inapplicable to bones found on any part of the eastern seaboard, where the climate is well known to be extremely moist even now, and must have been still more so when the country was covered with dense forest such as that which still surrounds or till within a few years did surround Dunedin harbour.

Leaving the occupied country and pushing north-west towards the Dunstan, the ranges were found covered with rich sub-alpine scrubby vegetation, the soil being deep and well pulverized by the frosts. The formidable spear-grass abounded in the gullies, being six to eight feet high, and flower-stalks four and five inches in diameter, but every here and there patches of good pasture were found. Paradise ducks and a few of the smaller species abounded near the lagoons and water-courses, and except a few small black hawks, larks and grass-birds were the only representatives of the feathered tribes met with. Pigs, which abounded on the eastern side of the Lammerlaw range, had not found their way westward at that time, nor indeed were they ever abundant in the far interior, but wild dogs of a great variety of breeds were commonly seen, living chiefly upon ducks; every swamp and creek-side having well-beaten dog tracks along their margins. These dogs were very tame, or rather had no sense of danger, as they used to sit down at a short distance and watch

the party in a very cool manner. They comprised many varieties, some being evidently collie or sheep dogs, and a bull terrier was also seen, but all of breeds that had escaped from Europeans. As an instance in proof of this, Mr. Buchanan mentions that a spotted coach dog that escaped from Mr. Jones at Waikouaiti, gave rise to a numerous and easily recognized progeny of wild dogs. These dogs are therefore not to be confounded with the true wild dogs of New Zealand, of which only a few specimens have been obtained, and always in dense bush such as the district between the Mataura and Waikava. Rats were also present in this country, but did not form so conspicuous a feature as in later years.

In the wide extent of the Manuherikia and upper Clutha basins, which are occupied by beautifully moulded terraces, the character of the vegetation was different from that on the ranges. The terraces were covered by a smooth, equal, but sparse growth of short green grass, that from a distance appeared like the turf of a well-trimmed lawn, but on walking over it proved only to be a thin scattering of grass plants with very light soil between, that rose in clouds of dust on being disturbed. A fire had evidently only a short time previously run over these plains, and from the total absence of all larger vegetation it is very probable that, owing to the dryness of the soil, the fires had done their work more thoroughly than on the ranges. It is therefore not to be wonderdd at that no Moa bones were observed on these level terraces, although it is in the recent alluvium and in the crevices of the rocks surrounding this very district that all the freshest specimens have been lately obtained. Indeed, so far as bones on the surface are concerned, the very dryness of the climate, which might be suggested as a reason for their preservation, was the actual cause of their more thorough destruction, by favouring the passage of fires over the district. Near the rivers the level flats that are liable to be flooded and altered during freshets were occupied by a very dense growth of scrub, chiefly of *Olearia virgata* and *Coprosmas.* On the more open parts of the river-bed Maori cabbage grew in great luxuriance, the stems forming thickets 4 or 5 ft. high, through which it was difficult to force a path. In this river-bed scrub Moa bones were abundant, and it is in sandy ground occupying this very position that the remarkably perfect skeleton now in the York Museum, and more recently the Moa feathers, were found. The only trace of natives seen by the party was an old cultivation, about an acre in extent, in the Dunstan gorge, which could not have been long abandoned, as the crop of Maori cabbage with which it was stocked had not spread beyond the line of the fence ; but many other traces of the visits of natives have since been discovered by the diggers. Among other things, Mr. John Graham in 1865 found a roll of tapa cloth under one of the overhanging rock caves which are so common in the district, and I have myself found fishing appliances and bags made of kelp in similar positions, but lower down the river.

This account of the features of the interior of Otago prior to its occupation by Europeans goes to establish that the destruction of the original forest and the destruction of the greater number of Moas must have been coincident, and that the after-growth which sprung up to cover the surface on which the prostrate trees and Moa bones lay was still growing on the ranges over which Mr. Garvie's party pushed their way, but that the burning on the terraces in the dry basins had been so frequently repeated that the vegetation had been at that date reduced to grass alone, and the Moa bones destroyed, just as has taken place during the last fifteen years over the whole of the rest of the country.

From the freshness of the timber lying on the ground, and the character of the growth that had succeeded it, no very great period could have elapsed since the last of the forest was destroyed; but the process of destruction was no doubt gradual, the heavy bush on the slopes of the hills being first reduced to clumps and patches, then confined to gullies, and finally exterminated in the same manner as can be observed in wooded parts of New Zealand at the present day.

But it must not be forgotten that a large area of the rolling country in Otago was much too high ever to carry forest, and this was no doubt the reason for the extraordinary profusion of Moas in this district, as they would feed on these large open patches, which must have had an extent of some thousand square miles.

As a great deal has been said about the absence of any mention of the Moa in Maori legends, I will read a note which Mr. Mantell has just received from Sir George Grey, in reply to an inquiry on the subject, and in passing I may state that Mr. Mantell himself has no doubt that the South Island natives, when he first collected Moa bones with their assistance, were well acquainted with their nature, and that they belonged to a bird that had become extinct quite recently.

In this note Sir George Grey says, "About the Moa I can only say that when I came to New Zealand the old natives always represented it to me as a bird well known to their immediate forefathers. They gave it its name; it is not a fabulous animal with incoherent traditions, but was spoken of by them as the kiwi or other birds getting rare. They often spoke of its disappearance. Sometimes they told me it was possible there might still be living specimens in the Middle Island; others asserted that it had been entirely destroyed. If you turn to page 9 of the Maori poems I printed in 1853 you will find in an old Maori poem this similitude taken from its disappearance, 'Ka ngaro, i te ngaro, a te Moa.' Any old native will explain this poem to you."*

* Also further reference in poems, p. 324, and at p. 74 of the Maori Proverbs. Governor Weld writes to me that when he first explored the open country in the interior of the Marlborough province the natives living on the coast warned him to beware of the Moa, and if he met one not to get behind it as it could kick like a horse and would break his legs.

But I fear that I have dwelt on this subject at too great a length, being led away by the desire to remove the impression that the Moa was limited to a palæolithic period, which is characterized by Sir C. Lyell as a period marked by a difference in the surface features from those now prevailing, or even that a palæolithic period can be recognized at all in New Zealand, as such an hypothesis, if incorrect, as I believe it to be, would greatly mislead those who are investigating the already complicated subject of the migrations of the branches of the human race.

That the Moa lived and flourished during far more remote periods there can be no doubt, but I think the discovery of the bones of the neck of one of the largest species, with feathers, skin, and muscles attached, which is now in the Museum, far outweighs all the arguments that can be advanced, and as Professor Owen pointed out in his first published paper on the subject, shows that the Moa belongs to the same very recent period as the Dodo. I must not neglect to notice that in his latest paper on the subject Dr. Haast has modified his first hypothesis so far as to say that the Maoris are not a fresh migration, but are the direct descendants of the Moa-hunters, and falling back on the supposed inferiority of the early stone implements as proof that the Maoris had attained a higher degree of civilization, he argues that a great period of time must have elapsed to account for that improvement; but against this may be urged that until the Maoris acquired knives from the Europeans they must have cut with flakes of stone with sharp edges, whatever their state of relative advancement may have been, as they possessed no other implements to supply their place. The evidence of the absence of the highly finished weapons from the cooking ovens which Dr. Haast describes at the Rakaia camping place, while they abound on the surface of the ground, appears to me to prove only that the final destruction or departure of the Maoris from that locality was rather sudden, and that in consequence valuable articles were left lying about which were not likely to be found in cooking-places that were in common use. Besides, it is certainly probable that the Moas near the sea coast on the Canterbury plains would be among the first to be destroyed, and that this particular encampment may have been used from a very early date, perhaps a century before the final extermination of the Moa elsewhere. On a revision of the whole question I do not think that the evidence which has been adduced proves that the Moas were not existing in Otago in considerable numbers less than 200 years ago, and that a few might not have survived to within seventy or eighty years; but I am glad to be able to state that Professor Owen intends to reproduce in a collected form his valuable series of memoirs on the Moa, and he will, I hope, take the opportunity to review the different hypotheses which have been advanced on this interesting subject.

As relating to this discussion, I should call attention to the description of

the feathers and microscopic structure of the egg-shell of the Moa by Capt. Hutton, which confirms the modern classification that places the kiwi in a different class of birds from *Dinornis* and other *Struthionidæ*, as it proves the incorrectness of the generally received notion that the kiwi is the living representative of the Moa kind that has remained to the present time, the fact being that *Struthionidæ*, once so abundant, are no longer represented in the New Zealand fauna.

I will now ask your attention while I make a short reference to the geological conditions which prevailed in the New Zealand area at the time when the Moas may be supposed to have first appeared.

Dr. Haast, than whom there is no better authority on this matter, has stated that the Moa remains first appear in the glacier period, by which is meant, in New Zealand, the period of a former greater extension of the glaciers from their mountain sources.

The condition of New Zealand at this time is a point of great importance, if we keep clearly before us the problem that I have already stated as being one of the greatest interest to students, of the geographical distribution of animals and plants, and that is the period during which New Zealand has maintained its insulation from other large tracts of land.

I regret to observe that in some way the idea has got abroad that New Zealand and other southern lands have just recovered from a period of submergence, and that arguments based on this assumption have been used relative to an alternating of the ocean level between the Northern and Southern Hemispheres.

By others our south polar climate is supposed to have undergone great amelioration, and even in Sir Charles Lyell's latest manual we have the choice given to us of either floating ice or land ice as the origin of a boulder-drift, supposed to envelop the country, and to correspond in character to the great boulder-drift of northern Europe and America. I must protest against this, for I am not aware of any evidence of the existence in New Zealand of anything analogous to the glacial drift of the Northern Hemisphere. Our extensive ice-formed drifts are all valley deposits, and exactly analogous to the moraines in the Himalayas and other tropical mountain ranges. They consist of moraines lateral and transverse, most of which occupy vallies radiating from our alpine peaks and ranges, while some outlived the drainage system which they at one time obstructed, and in process of time have come to form the present summit levels, throwing the water in a new direction. But during the long period in which the glaciers were more extensive than now the shingle brought down by the ice-fed torrents was poured out of the mountain gorges to form steeply inclined plains flanking the ranges, with a surface fall of from 35 to 40 feet to the mile. No trace of submergence of the vallies can be

found during this long period, the great duration of which may be judged of from the fact that lake basins, 1,000 feet deep and 10 to 40 miles in length, must have remained filled with ice, whilst the highest alpine vallies, containing many thousand times their cubic contents, were being excavated, and the material being carried over them and distributed in the lower plains outside the ranges, a feature which was first pointed out by Mr. Travers in a paper describing the Rotoiti Lake district of Nelson, which was published in the "Natural History Review," in 1864.

Even if we resort to the neighbourhood of the sea-coast, where we might expect to find distinct signs of emergence, there the evidence is all in favour of a general subsidence of the land on a great scale during the post-pliocene period.

Vallies that were eroded by the extended glaciers in the hardest rocks, such as the sounds on the west coast of Otago, are now depressed far beneath the level to which they could have been eroded, as their extent and depth have no constant relation to the present area and altitude of the neighbouring mountain ranges.

In a similar manner, in the northern parts of New Zealand, where the rocky framework of the islands forms the coast line, and in situations where it has not been worn into precipitous cliffs by the surf, the vallies are prolonged beneath the water-level in a most distinct manner, forming deep water inlets and harbours, while the low shelving and sandy parts of the coast have a heaped up shore line that appears as if encroaching on the alluvial deposits. Except one raised beach—nowhere more than twenty feet above the sea-level, and which distinctly marks an irregular elevation of the land that has chiefly accompanied earthquakes since the first occupation of the islands by Europeans, and which may be examined at almost any point of this harbour—there is a total want of any inland cliffs, lines of sand-dunes, and ridges, and other familiar evidences of an emerged coast line.

The low country, where such evidence might reasonably be looked for, is invariably formed of marine strata of higher antiquity than the period of the extension of the glaciers, or of swamps that are either still exposed or have been overwhelmed by shingle deposits brought from a higher level by the rivers, as an example of which I need only refer to the sections which have been obtained in boring for artesian wells in Christchurch and elsewhere, which pass through shingle till they strike an old drift-wood bed at eighty to ninety feet beneath the level of the sea.

This peculiarity in the distribution of the alluvial deposits of the province of Wellington, and the important indication afforded by the limited altitude at which pumice drift is found in land-locked harbours not fed by streams that float down pumice from the interior, was adverted to in an early paper to the

Society by Mr. Crawford; and in our last volume Capt. Hutton, in his paper on the alluvial deposits of the Waikato basin, also arrived at the conclusion that the sea has never occupied that large area of slightly elevated land, the most modern marine beds in it belonging to the upper miocene period.

The mountains of New Zealand had, therefore, in all probability their greatest altitude during our great glacier period, but whether that period was attended by any marked changes in the climate analogous to the boreal conditions that prevailed during the equivalent period in the Northern Hemisphere can only be determined by a critical comparison of the fossil shells from marine formations belonging to the same period, if any such can be found.

Referring only to the South Island, and judging from the fossil plants that have been preserved in lignitiferous deposits belonging to the pliocene period, which even in the extreme south of Otago contain large masses of a resin allied to the kauri gum, I venture to anticipate that if there was any difference in the character of the climate at that time, it was not an extension of antarctic conditions, but the reverse. With regard to the period of greatest elevation, the interesting question arises whether New Zealand during that period continued to be isolated from other land areas, or whether its peculiar fauna and flora were established at a time still more remote. From the great depth of the ocean round the islands, and the wide expanse separating them from even the nearest islands—such as the Chatham and Norfolk Islands, both of which possess a closely allied flora—the physical changes required to produce the disseverance must have been enormous and have required a lengthened period for its accomplishment.

We must suppose that the plains of barely consolidated tertiary strata that have been raised above the sea, and over which the progenitors of the Moas first reached New Zealand, have entirely disappeared by denudation and submergence, leaving the remnant of the race of giant birds to inhabit the limited area of these islands from that distant period down to the present time.

If the hypothesis of an excess in the area of elevated land being the cause of the more powerful erosive action of the pleistocene glaciers is correct, since that time there must have been a steady diminution in the area of low-lying land and a gradual liberation of mountain slopes from their snow cap. The effect of this on the rapid diffusion of plant forms and the probable influence which it exercised on the production, by variation, of the species which now characterize our alpine flora, has been ably dealt with by your late President Mr. Travers, in the instructive series of lectures which he delivered two years ago to this Society.

The description of the physical features of this very important epoch in New Zealand geology has been chiefly undertaken by Dr. Haast in various

reports that have not been communicated to our *Transactions*, but there are various papers on the subject by Messrs. McKerrow, Beal, and Dobson, to which I can refer as showing that the striking phenomena of the New Zealand glacier period have not been neglected by the members of the Institute. I may mention that the lower portions of our tertiary formation have not yet received much notice in our *Transactions*, and with the exception of one paper by Captain Hutton, and lists of fossils by Mr. Traill and Mr. Buchanan, all the information that has been obtained respecting them since the publication of Professor Hochstetter's work is to be found in the reports of the Geological Department, which, however, rather deal with local details than attempts at a general classification, which will not be possible till a critical tabulation of the large collections of fossils, a work on which I am glad to say Capt. Hutton is now engaged, has been effected. These formations embrace a very long interval of geological time, and form several very distinct groups both in mineral character and in the fossils they contain, the lowest of which I incline to think extends into the upper secondary (cretaceous) period. The upper groups are marine, and the lower chiefly fluviatile and of great importance to the colony from its containing the principal deposits of mineral fuel on which we have to depend for our supplies of coal, and notwithstanding the comparatively modern period to which this coal formation belongs it contains coal seams of a valuable character. In the associated sandstones and shales the flora of the period has been in many cases well preserved, and shows that at a period anterior to the deposit of the marine stratum the New Zealand area was clothed with a mixed vegetation of dicotyledonous leaves and ferns that in general character represent those which now constitute the flora of the country.

It would appear from the recent surveys by Dr. Haast that the large saurian reptiles in the Amuri and Waipara beds, the collections of which have been added to largely during the past year by the exertions of Mr. Henry Travers, lived during the formation of these coal seams, and coeval with them was a species of the kauri tree, the leaves of which have been found imbedded with the reptilian bones. May we speculate that even at this still more remote period, which was probably prior to the elevation of a great part of the Swiss Alps, New Zealand formed part of an area that possessed an insular flora, the peculiar characters of which have been preserved to the present time. Only a very skilful investigation and comparison of ample collections of fossil plant remains can determine this.

Such speculations as those on which I have lightly touched are a legitimate incentive to research, and I therefore make no apology for the theoretical character of the subjects on which I have addressed you this evening.

It is no doubt very satisfactory to have the proceedings of our Society

represented in the annual volume by valuable treatises that cannot be controverted, but a little theory now and then in our papers may perhaps awaken interest and provoke friendly discussion, which I take it is one of the most useful objects of our association.

With reference to the views expressed in the address, the Hon. Mr. Mantell remarked that there was a legend extant of a native having killed a Moa and taken the skin to Hawaiki.

Captain Hutton pointed out that the Maoris could possess no traditions of the cassowary or emu that would account for their knowledge of the Moa, as these birds do not belong to any islands where the race of men from which the Maoris are derived are found.

The Hon. Captain Fraser thought at one time that the destruction of the Moa had been accomplished by a race antecedent to the Maoris, which, nine years ago, he had described to the Ethnological Society of London as a race who grilled their food, in distinction to the Maoris, who bake their food, but his recent explorations had convinced him that that view was incorrect.

Dr. Comrie, H.M.S. "Dido," stated, with reference to the remarks about leprosy, that it had been introduced into the Sandwich Islands since 1852 by Chinese coolies imported to work the sugar plantations, and that it was spreading rapidly amongst the natives. One of the greatest authorities on such diseases had suggested to him that the peculiar virus might have been imported in the dried fish which the coolies carry about with them as food.

Mr. Carruthers stated that a form of this disease is not uncommon among the negros in the American States.

1. "Note on *Colluricincla concinna*, Hutton," by Capt. F. W. Hutton, C.M.Z.S. (See *Transactions*, p. 226.)

2. "Notes on Parasitic Animals," by F. J. Knox, L.R.C.S.E.

This paper was descriptive of certain cases in which parasitic animals had been observed in New Zealand in man and the lower animals.

3. "Note on *Ctenolabrus knoxi*," by F. J. Knox, L.R.C.S.E. (See *Transactions*, p. 308.)

FOURTH MEETING. 21*st August*, 1872.

Dr. Hector, F.R.S., President, in the chair.

New members.—W. F. Parsons, R. Collins.

1. "On the Life and Times of Te Rauparaha," Chapters I. and II., by W. T. L. Travers, F.L.S. (See *Transactions*, p. 19.)

2. "On the Stone Period of South Africa," by Dr. Comrie, of H.M.S. "Dido."

The author gave an account of implements and remains belonging to the stone period at the Cape of Good Hope, and specimens were laid on the table. They were of two kinds: Stone flakes found in circular cooking-places: and shells, and bones of animals that had been used as food, cemented into a breccia, in caves 200 feet above sea-level. The author considered that neither belonged necessarily to a period of great antiquity, and quoted accounts of the condition of the natives at the Cape by the first European discoverers, to show that their habits were such as would account for these remains, although the tribes having such habits have entirely disappeared.

The President pointed out the similarity of certain circular stone implements perforated with a hole, which were in Dr. Comrie's collection, to those in the Colonial Museum from Denmark, and also to some still in use in North Queensland, which have been presented by his Excellency Sir George Bowen.

3. A beautiful collection of ores and products, prepared from minerals obtained in the province of Nelson, was exhibited and explained by Mr. Tatton. There was also on the table a fine collection of tin ores, from New South Wales, presented by Mr. T. Beck.

FIFTH MEETING. *28th August*, 1872.

Dr. Hector, F.R.S., President, in the chair.

New member.—H. Nicholas.

1. "On South American Geology and Topography," by J. C. Crawford, F.G.S.

(ABSTRACT.)

The author proposed to show what connection exists and has formerly existed between this country and South America. He said it appeared that the fossil shells of littoral character of tertiary times found in New Zealand and in South America have much in common, the relationship being much nearer than between New Zealand and Australia, and that the floras of the former countries have also a considerable number of species common to both.

"It is almost impossible to resist the inference that in tertiary times (notwithstanding the great extent of deep sea which now separates the shores of New Zealand and of South America) these countries were more intimately connected, probably by land towards the antarctic circle, but at all events by a considerable extension of land in that direction, with the necessary consequence of a shallower adjacent sea, and with probably a large extension of the

land area, both of New Zealand and of the southern part of the American Continent."

He then proceeded to show that if a great depression were to take place in the Northern Hemisphere a corresponding rise would occur somewhere else, probably in the Southern Hemisphere, and a considerable amount of water being also drawn off to fill up the gap formed by the northern depression, these two causes would probably together have allowed of a junction between New Zealand and South America in the direction of South Georgia and Mounts Erebus and Terror.

The author then gave a vivid description of the country from Buenos Ayres to Mendoza, and of the grand scenery of the Andes between that place and Santiago. Between Valparaiso and Santiago the country had been travelled over by him, and with regard to the river Maypo he says that it "attracted the attention of Darwin from the constantly grinding noise of its shingle bed. This will recall to the New Zealand reader the grinding sound from the beds of the Rakaia, Waitaki, and many other New Zealand rivers." "The southern parts of the Andes and the deeply intersected district of Tierra del Fuego point to similar conditions to those of Dusky Bay, Milford Sound, and the other depressed vallies of the south-west coast of New Zealand. Tierra del Fuego appears to be composed of granites and silurian schists."

The author concluded with a general description of the continent of South America, and finished by saying that "there is a certain resemblance between the Southern Indians and the Maori, both in colour and fleshiness. The Patagonians whom I have seen were men with large bodies and short arms and legs. Sitting on the ground or on horseback they would appear gigantic, but standing up they would not be beyond the average height. It would, however, be an injustice to the Maori to compare him intellectually with the southern tribes of America."

A discussion ensued, in which Drs. Comrie and Hector and Capt. Hutton took part.

2. "Contributions to the Ichthyology of New Zealand," by Capt. F. W. Hutton, F.G.S., C.M.Z.S. (See *Transactions*, p. 259.)

The President stated that he had obtained from the fishermen in Wellington many of the specimens described by Capt. Hutton, showing that there is still rich field for discovery in this branch of natural history.

3. "Notes on the Stone Epoch at the Cape of Good Hope," by B. H. Darnell; communicated by Dr. Hector. (See *Transactions*, p. 138.)

4. "Notice of a new species of *Senecio* (*S. hectori*)," by John Buchanan, of the Geological Survey of New Zealand. (See *Transactions*, p. 348.)

SIXTH MEETING. *4th September,* 1872.

Dr. Hector, F.R.S., President, in the chair.

New member.—F. M. Betts.

Several publications received for the library since the last meeting were laid upon the table.

The President exhibited several specimens of towelling, made by Mr. Forbes, of Arbroath, from pure *Phormium,* and pointed out the great advance which had been made during the last six months.

1. "On the Life and Times of Te Rauparaha," Chapter III., by W. T. L. Travers, F.L.S. (See *Transactions,* p. 41.)

2. "A Description of the Earnsclough Moa Cave," by the Hon. Capt. Fraser, F.R.G.S. (See *Transactions,* p. 102.)

3. The President read "Notes by Dr. Buller on the New Zealand Hawk," which had been contributed in a letter to the "Ibis," a London scientific journal. In it Dr. Buller asserts his belief that there are in reality in New Zealand two distinct species of hawks, resembling each other in plumage in both the young and adult states, but differing appreciably in size. This had been questioned by Dr. Otto Finsch, of Bremen, and Dr. Buller gave his argument in support of his theory. He also says "with regard to the data furnished in Capt. Hutton's catalogue, I would simply remark that there is no evidence whatever of the sex having been, in a single case, determined by dissection."

With reference to this Capt. Hutton remarked that the specimens he had reported on were marked by Dr. Buller himself, who probably had made a mistake in the symbols commonly used for distinguishing the sexes.

4. "On the Geographical Relations of the New Zealand Fauna," by Capt. F. W. Hutton, C.M.Z.S. (See *Transactions,* p. 227.)

Part only of this paper was read, and discussion was deferred till next meeting.

SEVENTH MEETING. *11th September,* 1872.

Dr. Hector, F.R.S., President, in the chair.

1. "On the Geographical Relations of the New Zealand Fauna," by Capt. F. W. Hutton, C.M.Z.S. (See *Transactions,* p. 227.)

This was the concluding part of the paper begun at the last meeting of the Society.

Mr. Travers drew Capt. Hutton's attention to the fact that Mr. Rochfort had seen newts in a lake on the top of Mount Arthur; that he had in his garden a carnivorous slug, and he also referred to a red parasite he had seen on a reptile on his station. He thought many distinctive forms of life had been introduced from other countries, but owing to the time required for distribution they were but imperfectly known.

Dr. Haast would like to know if submergence had only been partial. There was no doubt that New Zealand was originally part of a large continent.

Captain Hutton felt doubtful about the newts until he had heard further of the matter.

The President after discussing some of the points raised by Capt. Hutton, said that the Society should be congratulated on the paper, which was a practical application of the Darwinian theory.

2. "On the Birds of the Chatham Islands," by H. H. Travers; "With Introductory Remarks on the Avifauna and Flora of the Islands," by W. T. L. Travers, F.L.S., (See *Transactions*, p. 212.)

Mr. J. D. Enys asked if Mr. Travers could account for the gizzard stones of the kiwi being found in the Chathams, if it did not belong to it.

Mr. Travers said it might have been taken over by the Maoris, but it certainly did not belong to the islands.

A skeleton of a Wallaby, prepared by Dr. Knox, was exhibited.

Eighth Meeting. 18*th September*, 1872.

Dr. Hector, F.R.S., President, in the chair.

New member.—J. B. Bradshaw, M.H.R.

Publications received since last meeting were on the table.

1. The President read a letter from Dr. J. E. Gray, expressing his opinion that the Seal described by Dr. Hector in last year's *Transactions* as the young of the Fur Seal of the West Coast is in reality a different species. Dr. Hector gave reasons why he still adhered to his opinion on the subject, and was supported by Capt. Hutton.

2. "On the Chief Features of the Vegetation of the District between Maketu and Lake Taupo," by T. Kirk, F.L.S.

This paper gave an instructive account of the culture of tobacco by the natives in the vicinity of the Hot Springs, and urged the necessity of preserving the scanty remains of forest in the district, and of extending them by artificial plantation.

The President stated that the defect of the Taupo pumice soil as a pasture land is more a mechanical than a chemical one, and the thorough consolidation of the surface by the trampling of stock would greatly improve it.

Mr. Travers said with reference to a statement that horses in the district feed on cotton-grass in absence of more nutritious food, that even where grass is abundant horses prefer that plant and eat it greedily.

The President pointed out, with respect to the author's statement that the occurrence of the pohutukawa and other littoral plants on the shores of Lake Tarawera affords direct evidence of the former incursion of the sea into the interior, that the fact of the plants thriving in inland positions proves that they are not exclusively maritime, and is therefore of no value as evidence on this point.

3. "On the Date of the Last Great Glacier Period in New Zealand, and the Formation of Lake Wakatipu," by Capt. F. W. Hutton, F.G.S. (See *Transactions*, p. 384.)

Mr. Travers explained that it was a mistake to quote him as saying that the glaciers are now over-riding their terminal moraines. He had mentioned to Capt. Hutton that he found signs of this having occurred at some former time in the Nelson mountains, but the glaciers had now entirely disappeared from that district.

Mr. J. D. Enys considered that the author must have misunderstood the reports he quoted relative to the Canterbury plains. The fan-like shape of the surface, formed by deposits radiating from the gorges of the large rivers, had been clearly proved by levelling, and was shown in the sections referred to.

The President while appreciating the value of the paper as likely to maintain an interest in the subject, could not agree with the conclusions arrived at further than attributing, as he had always done, the erosion of the alpine vallies and the rock-bound lake basins to the scooping of ice. The level at which the water of the sea or lakes now stands in these valleys is, however, quite a different question. He admitted that the former extension of the glaciers may have been greatest in the older-pliocene, and have continued through the pleistocene period, and that he was perhaps wrong in the manner in which he employed the latter term, as it is now frequently used for post-pliocene, and all but the most recent formations. That the area of the mountain tops above the snow line influenced the extension of the glaciers, irrespective of the geological epoch, is proved by the fact that the glaciers from Mount Cook at the present time descend to within 700 feet of the sea level.

The Wakitipu Lake, he explained, occupies portions of two parallel vallies, connected by the middle arm, which intersects the backbone range of the district by a gorge, the sides of which are 6,000 feet above the bottom of

the lake. It could not have been formed by a single continuous scooping process in the present line of the lake, as if a depression had not otherwise existed the upper part of the glacier would have continued its excavation towards the Te Anau Lake, in which direction there is a low saddle. The soundings of the lake, which is fifty miles long, were taken in 1863 under his instructions by Mr. Hacket, and showed that the bottom is flat from side to side, and has an average fall of twelve feet in the mile from both ends towards the middle arm, where the bottom of the lake is 300 feet below the sea-level. The resemblance to the sounds on the west is complete, yet they are only forty miles distant, and are cut to more than 1,800 feet beneath the sea-level, and in hard granite instead of the soft crumbling schists that are found round the Wakitipu. To explain this fact inequality of subsidence is certainly necessary; moreover, the occurrence of marine tertiary limestone on the shore of the lake inclined at 50°, and rising to considerable altitudes in the mountains, indicates movements in the rock masses of the district that must have contributed to determine the direction of the vallies.

The President supported Mr. Enys regarding the reports on the Canterbury plains by Dr. Haast and Mr. Doyne, and from his own knowledge said that nothing was more clearly established than the regularly curved contours of surface deposits concentric to the points where the great rivers emerge from the mountains. The existence of the terraces bounding the rivers as they cross the plains to the sea, he explained as being due to the gradual erosion of a notch in a rocky barrier where they leave the mountains, so that the river flows at a lower level, and cuts through its earlier formed alluvium. So far as the district of the Rakaia is concerned, the statement that the gravel formation wraps round the spurs of the hills at one uniform level is certainly not correct. On the whole, he thought no proof had been advanced of any submergence beneath the sea of the alpine districts since the last excavation of the great vallies by the glaciers. After quoting Sir Charles Lyell, who points out that the time required for similar excavation is so extensive that it covers a period during which we know that greater oscillations of level have taken place than are required to account for such inequalities, the President drew attention to the irregularity in the movement of the land during the earthquakes of 1848 and 1855, which amounted to nine feet elevation at Palliser Bay and was not perceptible at Porirua, while there is good reason to believe that in Blind Bay there was a marked depression. The elevation of the Bally Rock in Wellington harbour and the depression of the Hapuku Rock at the Astrolabe in Blind Bay, since the publication of the Admiralty charts, was also advanced as evidence that unequal movements have taken place on a small scale, and of course such may be cumulative throughout long periods.

NINTH MEETING. 25*th September*, 1872.

Dr. Hector, F.R.S., President, in the chair.

1. "Notes on Miramar Peninsula, Wellington Harbour," by J. C. Crawford, F.G.S. (See *Transactions*, p. 396.)

The author exhibited bones of various species of the Moa which have been found on the peninsula, and had been presented by him to the Colonial Museum.

The President said that the remains were as follows:—

(1.) *Human.*—Skull, pelvis, extremities, Lyall Bay; thigh bone, Evans Bay; thigh bones, etc., Ludlam Gully.

(2.) *Dinornis*, sp. *Moas.*—Femur (collected by Dr. Hector), Lyall Bay; sacrum and bones of extremities of small-sized species (femur, 6 inches), Ludlam Gully; tibia and other fragments of middle size—had been split and cooked (?), Evans Bay; femur and other fragments of middle size much incrusted with swamp deposit, Burnham Water, swamp; fragments of large size, sand deposit round Burnham Water.

(3.) *Cetacean* bones, Burnham Water.

(4.) Footbones of a *Calf*, Lyall Bay.

2. "On the Effect of Wind-driven Sand as a Cutting Agent," by Edwin Stowe, B.A. (See *Transactions*, p. 105.)

This paper was illustrated by specimens collected at Waikato Heads, and excited some discussion.

3. "Notes on the Anatomy of the Huia," by F. J. Knox, L.R.C.S.E.

These notes were descriptive of beautifully prepared skeletons of both male and female of these rare and interesting birds.

The President pointed out that the great difference in the length of the beaks in the male and female huia is due only to the prolongation of the horny mandible of the latter, the jaw bones being the same size in both sexes. This is not the case in the kiwi, in which the apparent excess in the length of the beak in the female is really produced by the lengthened bones of the face. Anatomically the kiwi has the shortest beak of any known bird of its size. The strong muscular crests in the skull of the male huia at once distinguishes it from that of the female, and supports the view that the male beak is used as an adze, and the female as a probe.

Capt. Hutton remarked that a recent paper read to the Zoological Society of London described the anatomy of the huia, and showed that it is allied to the starling and crow in its structure.

4. "On the Reclamation of Land devastated by the Encroachment of Sand," by C. D. Whitcombe. (See *Transactions*, p. 108.)

Mr. Travers gave an account of how the reclamation of land is effected near Bordeaux.

Mr. J. D. Enys pointed out that there was a dwarf gum tree in Tasmania that might be useful for this purpose.

The President said it was not merely the question of reclaiming land but also the protection of good land, and often of important works, mentioning the Cape Farewell lighthouse as an instance where protection against the drifting of the sand is an important consideration.

Mr. Travers exhibited a variety of the blue penguin (*Eudyptula minor*) recently captured at Evans Bay.

Mr. J. D. Enys exhibited the jaw of a tuatara, which he had found near Lyall Bay, and the skull of an ancient Maori dog which he had found in the cooking ovens at Paikakariki along with the bones of moas and men.

TENTH MEETING. *2nd October*, 1872.

Dr. Hector, F.R.S., President, in the chair.

1. "On the Life and Times of Te Rauparaha," Chapter IV., by W. T. L. Travers, F.L.S. (See *Transactions*, p. 51.)

Embracing the period from 1770 to 1817, and bringing down the account of that eventful period to the first conquest of the native tribes and the migration of the chief from Kawhia to Wanganui.

The President said in reference to a remark relative to Kawhia harbour that he had been there on board H.M.S. "Eclipse," and that he thought it would yet be a most important settlement.

2. "On the New Zealand Sertularians," by Capt. F. W. Hutton, C.M.Z.S. (See *Transactions*, p. 256.)

The author enumerated thirteen species, twelve of which he had found in Lyall Bay, eight of these being new to the New Zealand fauna, and five new to science.

The President gave a short account of the Turner reef, which had been discovered near Jackson harbour, on the south side of Cook Strait. The reef had been traced on the surface for about 1000 feet, crossing the promontory between Queen Charlotte Sound and Point Gore, and yields on an average, by several analyses, half an ounce to the ton. Some specimens are, however, very rich. The rock is a foliated schist, and quite different from the rock in which the gold is found on Baker's Hill and Terawiti, which has more resemblance to the bed rock at the Inangahua reefs.*

* See Geological Reports, 1872, p. 125.

ELEVENTH MEETING. *9th October*, 1872.

Dr. Hector, F.R.S., President, in the chair.

1. The Hon. W. Fox gave an account of his travels on the West Coast of the South Island. A large number of sketches illustrative of the scenery which Mr. Fox had witnessed during his travels in Switzerland, as well as on the West Coast, were exhibited on the walls of the building, and these, by the aid of the very fine light, showed to considerable advantage, and were admired as much for the grandeur of the scenery depicted as for the excellence of the sketching. The author made no attempt to treat the subject of glaciers in a scientific manner, but merely from what might be termed a picturesque point of view. A glacier may be described as a mass of ice occupying a deep gorge in the mountains, resembling the letter U in shape, its dimensions being many hundred feet in thickness, and from one to fifty miles long. This mass of ice does not remain, as might be supposed by unscientific observers, in a state of repose, but is in a constant state of forward progression. The rate of advance had, however, long been a subject of dispute, and various theories were propounded on the subject, the first being that the cause of motion is due to gravity and dilatation—from the melted waters pouring into the rents and crevices upon the ice becoming frozen and by expansion moving the mass forward. A more satisfactory theory, however, has been promulgated, which is that the great body attains the forward motion on account of its viscidity, the ice not being, as is generally supposed, a hard mass, but rather of a flowing or lava-like consistency, which the ladies of the auditory might better understand by drawing upon the homely article "dough" for comparison. This theory would better account for the fact that in glacier vallies it was often found that they had narrow mouths, wide above and narrow at the bottom, which overcame the difficulty of explaining how what was generally supposed to be a hard mass obtained egress through the mouth. Mr. Fox then explained the limitation of the glacier formation upwards, and the strange conjuncture of the *névé* with the lower portion, where the snow assumes a frosted condition, or, as the Germans call it, *firner*. The extraordinary depth of the crevasses and the danger to travellers formed a point in the subject which was explained in an interesting manner, Mr. Fox stating that the existence of these crevasses explained how the glacier vallies became the sources of rivers, the melting of the ice and snow percolating through the great body collecting in the bottom of the valley, and forming a tunnel before escaping into the open day. The causes and origination of moraines was the next point made clear, after which Mr. Fox alluded to the curious circumstance of the glaciers at their termini advancing and retiring at particular seasons, which accounted for the appearance of moraine hills at considerable

distances below the present termination of the glaciers. In remarking on the features connected with the New Zealand glaciers, Mr. Fox alluded to the remarkable fact that on the eastern slopes the New Zealand Alps terminated at a much higher altitude than on the western slopes, and that the glaciers on the east carried downward large masses of rocks, while the slopes of those of the west were composed of clear blue ice, from which little refuse or *dêbris* was carried down. Mr. Fox next made an interesting comparison between the glaciers of New Zealand and Europe, pointing out that while in the case of the latter no vegetation other than the common fir-tree was to be seen in their vallies, those of the West Coast of New Zealand were invariably beautified by a most luxuriant semi-tropical vegetation of flowering plants and tree-ferns.

An interesting discussion ensued upon a point to which Mr. Fox made allusion in his concluding remarks, that of the peculiarity of the glaciers always remaining at the same temperature of 32°, a fact which was rendered more peculiar by the circumstance that if a mass of ice were brought from any other place it would speedily melt in the heat of the sun, while the composition of the glacier would remain in its frozen state.

The President said that New Zealand presented a fine field for alpine exploration, and described four different groups of the Southern Alps from which glaciers radiate, showing that the glaciers are not now of the greatest magnitude in the furthest south, although they evidently had been so formerly. He considered that the reduction of the area of mountain top above the snow line by the cutting back of the glaciers was one of the chief causes of their disappearance. He pointed out that it was hardly correct to say a glacier retired from its moraine, as is frequently done. The fact is that in some years it melts more rapidly than in others, and on the West Coast these years of greatest waste would always, owing to the same causes, be the years when there would be least supply, but there could be no retraction of the mass of ice.

This led to some discussion, in which Capt. Hutton, Rev. Mr. Andrew, Bishop Hadfield, the Hon. Mr. Hart, and the Hon. Capt. Fraser took part, at the conclusion of which a vote of thanks was unanimously voted to Mr. Fox.

2. "On New Zealand Lake Pas," by the Rev. Richard Taylor, F.G.S. (See *Transactions*, p. 101.)

3. "On the Life and Times of Te Rauparaha," Chapter V., by W. T. L. Travers, F.L.S. (See *Transactions*, p. 62.)

TWELFTH MEETING. *23rd October*, 1872.

Dr. Hector, F.R.S., President, in the chair.

New members.—Rev. R. Taylor, F.G.S., John Clarkson, Charles Napier Bell.

Mr. Charles C. Graham was chosen to vote in the election of the Board of Governors for the ensuing year in accordance with clause seven of the New Zealand Institute Act.

1. "Notes on some of the Birds brought by Mr. Henry Travers from the Chatham Islands, with Descriptions of the New Species," by Capt. F. W. Hutton, C.M.Z.S. (See *Transactions*, p. 222.)

2. "Description of the Extinct Gigantic Bird of Prey Hokioi," by a Maori; communicated by Sir G. Grey, K.C.B., Hon. Mem. N.Z. Inst.

(TRANSLATION.)

This bird, the Hokioi, was seen by our ancestors. We (of the present day) have not seen it—that bird has disappeared now-a-days. The statement of our ancestor was that it was a powerful bird, a very powerful bird. It was a very large hawk. Its resting place was on the top of the mountains; it did not rest on the plains. On the days in which it was on the wing our ancestors saw it; it was not seen every day as its abiding place was on the mountains. Its colour was red and black and white. It was a bird of (black) feathers, tinged with yellow and green; it had a bunch of red feathers on the top of its head. It was a large bird, as large as the Moa. Its rival was the hawk. The hawk said that it could reach the heavens; the hokioi said it could reach the heavens; there was a contention between them. The hokioi said to the hawk, "what shall be your sign?" The hawk replied, "kei" (the peculiar cry of the hawk). Then the hawk asked, "what is to be your sign?" The hokioi replied, "hokioi-hokioi-hu-u." These were their words. They then flew and approached the heavens. The winds and the clouds came. The hawk called out "kei" and descended, it could go no further on account of the winds and the clouds, but the hokioi disappeared into the heavens.

"Kei" is the cry of the hawk. "Hokioi-hokioi" is the cry of the hokioi. "Hu-u" is the noise caused by the wings of the hokioi. It was recognized by the noise of its wings when it descends to the earth.

3. "On the Origin in New Zealand of *Polygonum aviculare*, L.," by W. T. L. Travers, F.L.S. (See Transactions, p. 310.)

In the discussion that followed Mr. Travers stated that he did not believe that Capt. Cook succeeded in introducing the potato and grasses, but that the seeds he scattered were anti-scorbutic plants.

4. "Description of a Reflecting Telescope made in Wellington," by W. F. Parsons; communicated by Dr. Hector, F.R.S. (See *Transactions*, p. 125.)

The instrument described was exhibited, and the use of certain machinery employed in its construction was described by Mr. Parsons.

Mr. Travers asked why the speculum was not made of metal instead of glass.

Mr. Parsons explained that metal was likely to corrode, and that the glass speculum could always be resilvered and made as good as new. Besides that the glass specula prepared by Browning's process gave greater light than any others.

5. "Observations on the Comparative Anatomy of the Penguin," by F. J. Knox, L.R.C.S.E. The author gave a demonstration of two beautifully prepared skeletons of *Eudyptes pachyrhynchus* and *Eudyptula minor*, which were exhibited.

Mr. Travers did not think the penguin was a deep diver.

Capt. Hutton, on the other hand, considered that the penguin's wings were particularly adapted for diving.

6. "On the Kingfisher (*Halcyon vagans*) and the Green or Striped-faced Wren (*Xenicus longipes*)," by T. H. Potts, F.L.S. (See *Transactions*, p. 171.)

Capt. Hutton said he thought the name *Xenicus longipes* was incorrect, and that it probably should be *X. stokesii*, but Mr. Potts had taken the name from Dr. Buller's work now being published.

Captain Hutton said in answer to Mr. Graham that the increase of the Kingfisher might be due to the increase of cultivation, for they lived chiefly upon insects.

7. "On the Absorption of certain Alkaloids by Aluminous Silicates," by W. Skey, Analyst to the Geological Survey of New Zealand. (See *Transactions*, p. 375.)

8. "On the Proposed Substitution of Acetate for Sulphate of Copper in the Manufacture of Iodine," by W. Skey. (See *Transactions*, p. 376.)

9. "Critical Notes upon the alleged Nuclear Action of Gold reduced from Solution by Organic Matter," by W. Skey. (See *Transactions*, p. 372.)

10. "On the Mode of producing Auriferous Alloys by Wet Processes," by W. Skey. (See *Transactions*, p. 370.)

11. "On the Formation of Gold Nuggets in Drift," by W. Skey. (See *Transactions*, p. 377.)

12. "Directions for Raising and Spreading *Ammophila arundinacea* and *Elymus arenarius*," by J. C. Crawford, F.G.S. (See *Transactions*, p. 111.)

THIRTEENTH MEETING. *30th October*, 1872.

Capt. F. W. Hutton, F.G.S., in the chair.

New member.—J. Monteith.

Meteorological Records from Batavia, Java, and the Royal Dutch Meteorological Institute were laid on the table.

1. "On the Life and Times of Te Rauparaha," Chapter VI., by W. T. L. Travers, F.L.S. (See *Transactions*, p. 73.)

Capt. Hutton pointed out the value of this paper, not only from an historical point of view, but on account of the mention it made of the introduction of animals and plants into the colony. He also stated that Captain Cook planted potatos in Queen Charlotte Sound, but the natives not caring to cultivate them, they were not propagated. Captain Cook also let out fourteen pigs in Queen Charlotte Sound, and four in the North Island, near Cape Kidnappers.

Mr. Travers thought the pig introduced by Captain Cook was a different kind from that now found wild.

Mr. Nicholl said that in 1842, when the early settlers landed in Nelson, wild pigs were very abundant.

Capt. Hutton explained that Captain Cook brought pigs from Polynesia as well as from the Cape of Good Hope, and that therefore he probably introduced two species.

Mr. Brogden read a calculation, according to which ten pigs, half of them being females, would produce fifty-two millions of pigs in ten years.

2. "On the Skeleton of an Aboriginal Inhabitant of the Chatham Islands," by F. J. Knox, L.R.C.S.E. (See *Transactions*, p. 304.)

FOURTEENTH MEETING. *6th November*, 1872.

Dr. Hector, F.R.S., President, in the chair.

New member.—J. Barleyman.

The nomination for the election of honorary members of the New Zealand Institute was made, in accordance with Statute IV.

1. "On the Influence of Change of Latitude on Ships' Compasses," by Commander R. A. Edwin, R.N. (See *Transactions*, p. 128.)

The President remarked on the great practical importance of the subject, and hoped the author would be able to suggest some practical steps to be taken for the protection of the public. With the late Mr. Balfour he had

gone a little into the question on the occasion of the loss of the p.s. "City of Dunedin," and certain errors were discovered in the cards of correction in the possession of some coasting steamers that may in part have been due to the causes pointed out by Captain Edwin, and which he did not think were taken into account by Mr. Balfour.

2. "On Moa Beds," by W. B. D. Mantell, F.G.S. (See *Transactions*, p. 94.)

This paper excited some discussion, in which Messrs. Hutton, Wain, Graham, and others took part.

3. "An Account of the First Discovery of Moa Remains," by the Rev. Richard Taylor, F.G.S. (See *Transactions*, p. 97.)

The author described his first discovery of Moa bones on the East Coast, in 1839, and the discovery of the particular deposit under consideration in 1843. The Maoris told him of traditions of how they had regular battues of the Moa at this place, driving them into swamps, where they were easily despatched. The name given to the Moa on the East Coast was Tarepo, and not Moa, but this word is not used elsewhere. The Maoris had distinct knowledge of the Moa, and copies of hunting songs, in which the bird is mentioned, are in existence. All the Moa bone deposits he had seen were superficial, and there was a mistake made in quoting him as saying that the bones at Waingongoro were mixed with marine strata. They were in cooking-ovens that formed numerous layers separated by drift sand.

Capt. Hutton pointed out, with reference to the supposed absence of any traditional knowledge of the Moa as held by Dr. Haast, that in Hochstetter's "New Zealand" Dr. Haast is himself made responsible for such a tradition.

4. "On the Whales and Dolphins of the New Zealand Seas," by James Hector, M.D., F.R.S. (See *Transactions*, p. 154.)

5. "Further Notice of Bones of a Fossil Penguin (*Palæeudyptes antarcticus*, Huxley),"* by James Hector, M.D., F.R.S.

The author said "when describing the fossil bones of the large penguin, *Palæeudyptes antarcticus*, Huxley, in a paper published in last year's volume of our *Transactions* I find that I overlooked two very fine specimens that were in the Museum. They were presented by Mr. Charles Traill, who found them in the white calcareous sandstone which is excavated at Fortification Hill near Oamaru, in Otago, and which is well known as the Oamaru limestone.

"The bones are beautifully preserved in this matrix, which has been carefully cleared away to allow of the examination.

"They are the left humerus and the coracoid of the right side, and belonged,

* See *Trans.* N.Z. Inst., Vol. IV., 341.

I have no doubt, to the same individual bird as the metacarpal figured in last year's volume (Pl. XVII., fig. 3). The humerus is one-sixth of an inch larger than the same bone in the Brighton fossil, and has a more marine appearance. Judging from the proportion of the bones they must have belonged to a bird that had a stature of from six to seven feet."

Captain Hutton said he considered the age of the strata containing these bones to be upper eocene, and that they are therefore among the oldest bird remains known.

Mr. Travers mentioned the recent observance of a rare parrot-fish in the market (*Odax vittatus*), the specimen of which had not been preserved.

The President said there is a specimen of the fish in the Otago Museum, but none in the Colonial Museum.

6. "Notice of a New Species of Moth in New Zealand," by W. L. Buller, D. Sc., F.L.S. (See *Transactions*, p. 279.)

FIFTEENTH MEETING. *13th November*, 1872.

Dr. Hector, F.R.S., President in the chair.

New member.—James Bull.

1. "On the Life and Times of Te Rauparaha," (Chapter VII.) by W. T. L. Travers, F.L.S. (See *Transactions*, p. 84.)

2. "Lecture on the Formation of Mountains," by Capt. F. W. Hutton, F.G.S., C.M.Z.S. (See Appendix, p, xxv.)

The President congratulated Capt. Hutton upon having revived and so ably developed this ingenious theory, and thanked him on behalf of the meeting for placing before the members of the Society so difficult a subject in such a lucid manner.

SIXTH ANNUAL GENERAL MEETING. *1st February*, 1873.

James Hector, M.D., F.R.S., President, in the chair.

ABSTRACT REPORT OF COUNCIL.

During the past year fifteen general meetings have been held, which have been on the whole much better attended than in previous years. Forty-eight papers have been read, and most of them will appear in Vol. V. of the *Transactions*. The Proceedings of the Society have been regularly published

in the local newspapers, and an abstract is also sent to "Nature" for the early information of English scientific circles. The Library has received large additions during the past year by donation, purchase, and deposit. Works of reference have been ordered to the value of £26 17s. 6d., and a case of type insects has been sent for which will cost about £50. There are now 142 members, 20 having joined during the year.

The balance brought forward from the previous year was £97 19s. 6d.; the subscriptions amounted to £141 13s. 6d.; the expenditure being £144 2s. 4d., and the balance in hand £95 10s. 8d.

The President said the Council had considered the advisability of altering the rules of the Society. These rules had originally been framed for the New Zealand Society, and adopted without alteration by the Philosophical Society. The subsequent establishment of the New Zealand Institute had rendered alterations advisable, and he was instructed by the Council to lay before the meeting the suggested alterations.

The amended rules were gone through seriatim and adopted.

ELECTION OF OFFICERS FOR 1873.—*President*—Charles Knight, F.R.C.S., F.L.S.; *Vice-Presidents*—J. C. Crawford, F.G.S., F. W. Hutton, F.G.S., C.M.Z.S. *Council*—W. T. L. Travers, F.L.S., H. F. Logan, James Hector, M.D., F.R.S., John Kebbell, W. S. Hamilton, J. R. George, C. C. Graham. *Hon. Treasurer*—F. M. Ollivier; *Hon. Secretary*—R. B. Gore; *Auditor*—A. Baker.

New member.—Arthur Baker.

AUCKLAND INSTITUTE.

SPECIAL GENERAL MEETING. *4th January*, 1872.

T. Heale, President, in the chair.

This meeting was held to consider the state of the Building Fund, and the President detailed the various steps taken towards the formation of such a fund.

ANNUAL GENERAL MEETING. *13th May*, 1872.

T. Heale, President, in the chair.

New members.—Hon. J. D. Ormond, Hon. C. J. Taylor, R. C. Jordan.

The list of donations to the library and museum was read by the Secretary.

ABSTRACT OF ANNUAL REPORT.

Seven meetings have been held during the past year, at which twenty papers were read.

The Museum has been lighted with gas and kept open till 9 p.m. on every Wednesday, and has been well attended.

An effort has been made to raise funds for erecting a suitable building for a Public Museum and Free Library. The late Dr. Stratford liberally bequeathed £100 towards this object on condition of £400 being raised in sums of not less than £50. Liberal donations were also made by other people, but owing to the Provincial Council refusing to grant £1,000 in aid on condition of a similar amount being subscribed for privately the effort to raise the £2,500 required has been frustrated.

Numerous and valuable donations to the Library and Museum have been made, including a large number of valuable works from Capt. F. W. Hutton, F.G.S.

Eighty volumes have been added to the Library by purchase out of the Provincial grant, and purchases for the Museum from the same source are now on the way from England.

The receipts for the year ending 19th February, 1872, amount to £330 19s. 3d., and the expenditure to £298 18s. 11d., leaving a balance in hand of

£32 0s. 4d. The subscriptions for the year amounted to £155 8s., and the Provincial Government made a grant to the Society of £100 for the purchase of books and museum objects. The amount of £79 12s. 3d. has been expended in books, and £73 3s. on objects for the Museum.

Election of Officers for 1872.—President, T. Heale; *Council*—J. L. Campbell, M.D., T. B. Gillies, Rev. A. G. Purchas, M.R.C.S.E., Hon. Col. Haultain, T. Russell, T. Kirk, F.L.S., J. Stewart, C.E., H. H. Lusk, T. F. S. Tinne, J. M. Clark, Rev. J. Kinder, M.A.

Second Meeting. *24th June*, 1872.

T. Heale, President, in the chair.

New members.—T. L. White, S. P. Smith, N. Kelly, R. J. Pearce, E. Perkins.

The list of donations to the Library and Museum was read by the Secretary.

The President delivered the following anniversary

ADDRESS.

I propose, in opening this session, to take a slight and cursory review of some of the leading subjects which are agitating scientific opinion at home, and the familiarizing of which by discussion here should, in my opinion, form one of the leading objects of this Society, in due subordination, of course, to its proper function of investigating, discussing, and recording the natural phenomena around us.

The difficulty of keeping the mind at all on a level with current knowledge and advancement on the larger subjects of investigation, is one of the disadvantages incident to a colonial life. This disadvantage our Society has striven to lessen by obtaining, as far as its slender means have afforded, a nucleus of a scientific library, to which we hope to make continual additions, and which is freely open to the public. I propose to make an attempt to utilize these books, or at all events to draw attention to them, by one of those slight and conversational papers which I have before recommended, and which though not suitable for publication in our *Transactions*, inasmuch as it is not scientific, nor based on original investigation, may serve to stimulate attention and perhaps to elicit replies, and so to make our monthly meeting more interesting to those members not devoted to natural history.

I think I am safe in assuming that by far the leading place in scientific, or indeed in intelligent unscientific thought, is occupied in our day by the discussions arising out of the great and fertile theory of the development of species, propounded by Mr. Darwin; a theory which Prof. Huxley has happily

termed the *Novum organon* of biologists. It is true that the leading principles of Darwinism, that clear and luminous law of constant variation in the individual offspring of all creatures, and the survival of the fittest, have well nigh passed out of the pale of discussion, and have become almost universally received as an "established scientific truth.*"

But the value and importance of this theory is that it is not a simple discovery which once made has but to be accepted and registered in the records of science, but that it is the enunciation of a principle—a law—the operations of which have yet to be traced backwards into the remotest past, to the very origins of life, and forward to possible developments of it, perhaps yet undreamt of ;—a principle which has stirred to its depth every branch of science and thought, which has given them a fresh impulse and new aims, and has elevated what were before but collections of isolated facts into fertile elements of inductive reasoning, and evidences of an universal sequence of cause and effect leading continually onwards and upwards, from the humblest beginnings of life, to a future of which no limits can be discerned.

That such a theory should, in its larger developments, excite opposition was not only natural but desirable. Discussion, the conflict of opposite opinion, seems to be the sole means given to man for the certain discovery of recondite truth; and the fertility of a new principle may perhaps be measured by the amount of opposition and controversy it meets with on its promulgation.

But the chief objections taken to Darwinism are not to the theory in itself or in its nearer or more familiar results, but rather to some of the larger deductions which may be more or less hypothetically drawn from it—to some of its special applications, as the descent of man—and especially to its sufficiency as the one law by which all the developments into which life has branched can be accounted for.

The views of the leading opponents, or rather modifiers of the theory, remaining in the field in our own language, and I do not profess to go further, are I imagine fairly represented.

1. By the Duke of Argyll in his well known book "The Reign of Law."

2. By Mr. St. George Mivart in "The Genesis of Species"; and

3. By Mr. Wallace, the co-discoverer of the law, and its most able and successful supporter, but who has suggested some limitations to it with far more effect, as it appears to me, than any of its avowed opponents.

Now the positions of the Duke of Argyll, as I understand them, are :—

1. He admits that the existing and past conditions of the world—that which we comprise in the idea of creation—have been brought about by the "use of means working to an end;" by the operation of that uniform, orderly, and invariable sequence of phenomena which we call a law; that this

* "Reign of Law," p. 219.

law is still in operation, and that branches of it, if not the whole, lie within the power of the intellect of man to trace, and therefore it must be man's duty to investigate and discover them.*

2. He recognizes the facts of natural selection, variation of offspring, the struggle for existence and the survival of the fittest—to a certain extent at all events—as a part of this law; or, as he prefers to put it, as "accounting for the success and establishment and spread of new forms when they have arisen."

3. But he opposes the true Darwinian view that the individual variations always occurring are infinite in number and in every direction, and that the fittest survives to the exclusion of the vast majority of other variations as a natural consequence of its fitness; but he demands in each case the exercise of a special will or creative act in directing the particular variation which is intended to survive, and which then does survive by reason of its having been created more fit for the new conditions surrounding it.

Now it is not the object of my present discourse to maintain or to dispute the truth of any of the views which I am merely adverting to as occupying attention elsewhere, and as eminently fit to become subject to investigation and discussion here; but I may fairly quote the strong and, as it appears to me, crushing answer to this last "providential" theory which Mr. Darwin himself has suggested. He asks, "Can it with any probability be maintained that the Creator specially ordained for the sake of the breeder each of the innumerable variations in our domestic animals and plants;—many of these variations being of no service to man, and not beneficial, far more often injurious, to the creatures themselves? Did He ordain that the crop and tail-feathers of the pigeon should vary in order that the fancier might make his grotesque pouter and fantail breeds? Did He cause the frame and mental qualities of the dog to vary in order that a breed might be formed of indomitable ferocity, with jaws fitted to pin down the bull for man's brutal sport? But if we give up the principle in one case,—if we do not admit that the variations of the primæval dog were intentionally guided in order that the greyhound, for instance, that perfect image of symmetry and vigour, might be formed,—no shadow of reason can be assigned for the belief that variations, alike in nature and the result of the same general laws, which have been the groundwork through natural selection of the formation of the most perfectly adapted animals in the world, man included, were intentionally and specially guided."†

Mr. St. George Mivart's recent book, "The Genesis of Species," is

* See "The Reign of Law," pp. 208–212.

† "Animals and Plants under Domestication," Vol. II., p. 431; quoted Mivart, p. 293. Also Wallace's "Natural Selection," p. 290.

one of a rather singular character, marked throughout by lines of thought not usually found in books of purely scientific discussion. Its object as stated by himself is, "to maintain the position that 'Natural Selection' acts, and indeed must act; but that still, in order to account for the production of known kinds of animals and plants, it requires to be supplemented by the action of some other natural law or laws as yet undiscovered. Also, that the consequences that have been drawn from Evolution, whether exclusively Darwinian or not, to the prejudice of religion, by no means follow from it, and are in fact illegitimate."* In maintaining these positions, he has brought forward some very unexpected witnesses, not against the doctrine of all or any of the varied forms of life having been evolved from earlier forms by the continued operation of a natural law, but in favour of it. He cites St. Augustine, St. Thomas Aquinas, Cornelius à Lapide, and the Jesuit Suarez, the eminent casuist of the Spanish School, for the positions that "in the first institution of nature we do not look for *Miracles*, but for the *laws of Nature*," and that terrestrial animals were created, not immediately, but "potentially only, the kinds of which time would afterwards bring forth." And, singularly enough, he maintains, by the aid of these novel witnesses in favour of the results of modern research, that the views even of the abiogenesists, so energetically maintained by Dr. Bastian, that life may be produced from inorganic matter without the presence of any living germ, and "that under fit conditions the simplest organisms develope themselves into relatively large and complex ones,"† are perfectly consistent with orthodox (Catholic) theology. But while admitting these apparently greater postulates, he strenuously objects to the sufficiency of the theory of natural selection to account for the derivation of species and especially to its having any share in that great development of some of the members of the order of primates, which has resulted in the appearance of men upon the earth. He insists upon the immense numerical chances against the survival of a variety, even the most favourable to the individual in the struggle for existence, if such variation should be produced only in single or in very few individuals in the presence of a great majority of a less favoured type. Again, he urges, and rather exaggerates the well-known arguments brought forward by Sir William Thomson, and established by him by transcendent mahematical analyses based on three different sets of physical hypotheses, by which he considers that he has proved that the world cannot have existed in its present condition suitable to the maintenance of animal life for more than "some such period as one hundred millions of years," and he labours to show that such a period would be insufficient for the phenomena on the Darwinian hypothesis; both of which propositions, I need hardly say, are in a high degree doubtful, as has

* "Genesis of Species," p. 5. † "Genesis of Species," p. 249.

been shown by many writers, and especially by Professor Huxley, in one of his best known papers.

Again, engrafting upon Darwinism the views propounded by some of the moral philosophers of the utilitarian school, especially Mr. Mill and Mr. Herbert Spencer, he argues against the views which he attributes to them, and apparently to the supporters of Darwinism generally, "that natural selection has evolved moral conceptions from perceptions of what was useful, that is pleasurable, by having through long ages preserved a predominating number of those individuals who have had a natural and spontaneous liking for practices and habits of mind useful to the race, and that the same power has destroyed a predominating number of those individuals who possessed a marked tendency to contrary practices," etc.*

It is clear that these views are by no means a necessary part of the doctrine of development of animals by natural selection and the survival of the fittest; but that they may be abandoned or disproved without any detriment to it.

The origin of purely intellectual conceptions as distinguished from mere animal instincts is no doubt one of the great difficulties, indeed the greatest which meets the evolutionist in taking account of the development of man.

Of however low a type we may conceive man to have been at the commencement, or even in the stone period (neolithic) for instance—however much below the Hottentot or Bosjesman—still, in the mere possession of a capacity for abstract ideas, a capacity which indeed was latent, but the existence of which is proved by the large brain, the step was immense, indeed infinite, and this has been recognized by Mr. Darwin and all the leading supporters of the doctrine of development; but to seek from natural selection the origin of a particular class of mental conceptions, a class too which the majority of moral philosophers deny altogether to be intuitive, and which many believe to be a comparatively modern outcome of culture and civilization, is surely a very unfair and inadmissible line of argument.

The origin and maintenance of a race possessing a capacity for the higher mental emotions and powers, which would appear to have been at its origin of no advantage whatever to the individual in the struggle for life, is indeed a great difficulty, the greatest the Darwinists have yet met.

This difficulty has been propounded, in a manner which I think will be considered by most minds to be incomparably more conclusive than as stated by Mr. Mivart, by one who is entitled to be considered the leading apostle of the Darwinian theory up to a certain point, the eminent naturalist in fact who first publicly propounded it, and so led Mr. Darwin to publish the

* "Genesis of Species," pp. 212–213.

investigations which he had been for many years engaged in making on the subject, and which were not then complete.

Mr. Wallace has raised weighty objections* which seem to suggest a further expansion of the theory so as to make it embrace some occasional and apparently violent or, at all events, sudden changes which would appear at first sight to be interferences with the course of law or to be "catastrophic," but which Professor Huxley has demonstrated may, though only occurring at intervals, be as much a part of the uniform law as those which recur rapidly.

Such difficulties and answers to them, more or less complete, are now agitating thinkers in every line of science; for it is the striking character of these discussions, and a noble result of Mr. Darwin's theory, that at last, after long pursuing divergent lines of investigation, all sciences are now meeting in front of this great question of the origin and development of life; the biologists and microscopists ardently disputing the possibility of its generation from inorganic matter; the anatomists investigating the mysterious functions of the brain and the curious facts of embryology; the palæontologist, the geologist and the botanist tracing up forms of life to the primitive type, and physiologists in common with metaphysicians labouring to the same end, seeking to obtain some notion of the action of will, mind, or spirit upon matter, or to ascertain if there be any real distinction between them. Astronomy and meteorology too have been brought to bear on the question, especially in the curious meteoric hypothesis suggested by Sir William Thomson, and Mr St. George Mivart's book affords a curious proof that this universal stirring of the mind has reached even to these tranquil regions of thought in which labours of the great scholastic philosophers of the middle ages and of the casuists who followed them usually repose.

I do not like leaving the subject without some reference to the reactions to which by an inevitable law of nature the great advances in thought made in our day have given rise; every sudden outburst of new light has produced a darkening effect in some quarters; and the eras of advance in the world have ever been marked by the wildest outbreaks of ignorance and superstition. A poet of the end of the last century says,—

> "As Phœbus to the world, is science to the soul,
> And reason now through number, time, and space
> Darts the keen lustre of her serious eye."

And he then proceeds to rejoice in the victory he supposes to be gained over superstition.

The triumph was premature; the advance in science indeed, since Beattie's day, has been far greater than he could have foreseen, but credulity has not diminished but has only shifted its ground, and seems rather to increase with

* Wallace's "Natural Selection," pp. 332–342.

the spread of knowledge than to show any tendency to disappear; nay instead of, as in his day, lurking in the dark places where—

"In the deep windings of the glen no more
The hag obscene and grisly phantom dwell,"

its acolytes seem to take advantage of the popular recoil against the clear, cold deductions of reason, to come out in the face of day, and to erect their emotional ecstasies into a system.

The most popular dream of our day, the so-called spiritualism, with its walking and talking tables, and other upholstery, has hitherto taken such a shape that serious minds have not been called upon to notice it, but now when I find in several numbers of a periodical with so imposing a title as the "Quarterly Journal of Science" serious papers on what the writer calls "psychic force," it cannot be unbecoming in anyone to refer to it. For my own part I find still the same want as before of any *facts* on which to found an induction, but whatever be the value of psychic force it is at all events a very curious and interesting fact in psychology that a gentleman of scientific eminence, and whose perfect good faith there is no reason to doubt, should really dignify by the name of experiments some oscillations produced in a balance, without apparent contact, by a professional conjurer (or "medium" which I take it is the modern slang for fortune-teller, as a barber now-a-days calls himself a professor) standing beside the friendly shelter of a dining table in connection with the apparatus, while the person who conducted the experiment, according to his own account, was engaged writing notes, and that forthwith instead of exercising his ingenuity in striving to find out "how he did it," he should deliberately attribute these shakings to a psychic force, which is to do away with or to suspend gravitation and all those laws on which physics and astronomy depend.

I cannot consider this curious case without my mind referring to the only explanation possible of the persistent hallucination which seems to have affected so many honest but utterly mistaken witnesses on the recent trial which has excited so much attention wherever our language is spoken. It seems that the "very improbable" has a singular fascination for many minds, and that with such persons, to quote the "Saturday Review," "as soon as the attention has been caught by some salient fact which they can believe, and which awakens their faculties of wonder, they become interested in believing the whole story, and their intellects succeed in representing every new fact as somehow confirmatory of the foregone conclusion. The lesson of the Tichborne case was an instructive one in many ways, for the secret of the claimant's power was precisely the secret upon which all spiritualists and other impostors depend for success. A man is first asked whether he has been the victim of a hoax, or the laws of nature have been suspended.

Naturally he prefers to believe that the laws of nature have been suspended, and from that moment he becomes unintentionally the ally of the impostor, and developes a strange ingenuity in evading all difficulties, and seizing every bit of evidence that seems to make in his favour." *

I had intended to have made some reference to spectroscopic science—to the wonderful perfection which has been attained in the measurement of minute intervals of time, intervals bearing the same proportion to a second that a second does to an hour—and especially to the great subject of astronomical interest, the approaching transit of Venus across the Sun's disc, which should be of particular interest to us, since its last occurrence in 1769 was the immediate occasion of the first exploration of these Islands, and the means of introducing them to the knowledge of the European world, and since this place is one of the forty-six stations determined on for observation of the ensuing one, by concert between the four Governments of England, France, Germany, and Russia. But I have trespassed at so inordinate a length on your attention that I will now conclude, with a hope that in the present session we shall not only have a continuance of the truly scientific papers which have hitherto given the transactions of these Societies a permanent value, but that our members, who like myself are without the technical knowledge and observant habits necessary to the collector and collator in the natural history sciences, will, nevertheless, take courage from the feeble attempt I have made to bring forward subjects requiring general and desultory reading only.

The Secretary drew attention to a remarkably fine specimen of *Solenognathus spinosissimus*, presented by Mr. Wyatt, of Mongonui, and to several other recent presentations.

1. "Notes on the Flora of the Lake District of the North Island," by T. Kirk, F.L.S. (See *Transactions*, p. 322.)

This paper was illustrated by numerous dried specimens of plants collected in the district and presented to the Museum by the Director of the Geological Survey.

2. A note by Capt. Hutton was read on the occurrence of the sprat and anchovy at the Thames, and specimens of these fishes, presented by Mr. C. O. Davis, were exhibited.

3. "On the Growth of *Phormium tenax*," by the Hon. Col. Haultain. (See *Transactions*, p. 357.)

* "Saturday Review," March 16, 1872, p. 331.

THIRD MEETING. *22nd July*, 1872.

The Hon. T. M. Haultain in the chair.

New members.—D. E. Macdonald, W. H. Floyd, H. P. Higginson, C.E.

The monthly list of donations to the Library and Museum was read by the Secretary. It included a copy of Loudon's "Arboretum Britannicum," eight volumes, from the Hon. Col. Haultain.

1. Referring to the occurrence of the sprat and anchovy at the Thames, as reported at the last meeting, Mr. G. Thorne, jun., stated that in 1867 a small herring had appeared at Melbourne in such abundant shoals that the water looked quite black at a short distance. It had not been seen in that locality since that date. He inferred from this that it was possible that the sprat and anchovy were not regular visitors to the Ourakei Gulf.

Mr. Kirk remarked that these fish had been observed at various parts of the coast of both islands, and he was inclined to regard them as periodical visitors which, until recently, had escaped notice.

2. "Notes on the Flora of the Lake District of the North Island," by T. Kirk, F.L.S. (See *Transactions*, p. 322.)

This was the concluding portion of the paper begun at the last meeting.

FOURTH MEETING. *19th August*, 1872.

T. Heale, President, in the chair.

New member.—Dr. Spencer.

A list of donations to the Library and Museum was read.

A collection of gems and precious stones, also several rare minerals, recently added to the Museum, were laid on the table.

1. "On the Flight of the Black-backed Gull (*Larus dominicanus*)," by Capt. F. W. Hutton, C.M.Z.S. (See *Transactions*, p. 140.)

2. "On the Occurrence of the Clover Dodder (*Cuscuta trifolii*) in the Waikato District," by Major W. G. Mair.

The existence of this vile parasitical plant in Waikato is a matter of serious import to agriculturists. As far as I can ascertain, it was first noticed in 1869. It is to be met with now on most of the farms about Ohaupo and Pukerimu. In some places it was first observed springing from horse droppings, and for this reason it is supposed by the settlers to have been introduced in horsefeed. It is unfortunate that its appearance was not remarked upon

earlier, for at this date it would be less easy to trace its origin. It shows itself early in the spring, and spreads outwards like a ringworm all through the summer till the beginning of autumn, when it disappears, leaving a circular patch; some of these patches have been seen fifty yards in diameter. In some instances, more especially in light good soils, as the circle extends the pasture springs up behind it, but upon heavy land the patch is usually quite denuded of vegetation. I have only seen it on red clover (*Trifolium pratense*) and cow-grass (*T. medium*) growing with such vigour that the unfortunate plant is quite hidden by the parasite. If taken in time its ravages may be checked by paring clean and burning, but if neglected during the first weeks of spring nothing short of turning up the whole field will destroy it. I am indebted to Captain Rich of Fernside (where I first saw the *Cuscuta* growing) for information touching its habits.

3. "Notes on the Naturalized Plants of the Chatham Islands," by T. Kirk, F.L.S. (See *Transactions*, p. 320.)

This comprised a catalogue of the introduced plants observed in a naturalized condition by Mr. H. H. Travers during his exploration of the islands.

4. "On Compound Engines," by W. Lodder. (See *Transactions*, p. 144.)

FIFTH MEETING. *23rd September*, 1872.

T. Heale, President, in the chair.

New members.—J. Henderson, J. Lackland, J. Lamb, J. M. Fraser, J. Webster.

The monthly list of donations to the Library and Museum was read by the Secretary.

1. "On the Rate of Growth of Native Trees under Cultivation," by J. Baber, C.E.

(ABSTRACT.)

In comparison with European and Australian trees, those of the North Island are slow in growth.

Trees of the following kinds were planted by me in 1851–52 at Remuera, at an elevation above the sea of 210 feet, on a clay soil (Waitemata series); the height these have attained during twenty years is given in the following table:—

	Ft.	In.
Ti (*Cordyline australis*)	24	0
Puriri (*Vitex littoralis*)	20	0
Mapau or Tipau, black var. (*Myrsine australis*) ...	17	0

	Ft.	in.
Pohutukawa (*Metrosideros tomentosa*) ...	16	6
Titoki (*Alectryon excelsum*)	14	6
Tanekaha (*Phyllocladus trichomanoides*) ...	14	0
Hohoheka (*Aralia crassifolia*)	14	0
Mapau, red var. (*Myrsine*, sp.)	13	6
Whauwhau	13	6
Kahikatea (*Dacrydium excelsum*)	13	0
Karaka (*Corynocarpus lævigata*)	12	0
Warengapirau (*Olearia cunninghamii*) ...	7	9

The average circumference of six puriri trees of twenty years growth, taken 12 inches above the surface of the ground, is 2 ft. 9 in.

As the puriri flourishes both on volcanic and clay soils if not flat, and its timber is durable and useful, I think that plantations of this tree will be profitable on broken ground suitable only for planting. The puriri will bear being made a pollard, which is an advantage.

2. "On the Cultivation of Native Trees," by D. Hay.

(ABSTRACT.)

Kauri Pine (*Dammara australis*) is the largest and most useful of all the New Zealand trees in a commercial point of view.

The seed is produced from a round cone, flattened at the apex, concealed under thin smooth scales, rounded at the top. The seeds are flat and very light, with a wing attached to each. The cone falls to the ground when ripe, and owing to the great height it has to fall separates immediately it touches the ground, or even before, in the latter case the seeds being often carried a long distance by the wind. It vegetates soon after it falls, and will not bear to be kept dry for any length of time, the seed being very difficult to transport on this account. The seeds are interspersed among the decaying vegetable matter, and many find a congenial soil in which to start into life.

As the temperature of the bush is much warmer than that of the open country it is but natural to suppose that a plant will not succeed when removed from its natural habitat with all its roots entire inclosed in a ball of earth, and planted in an open situation. Shortly after removal the leaves assume a reddish hue, which is caused by evaporation from the cold wind and strong rays of the sun. The proper method to remove young kauri seedlings, not over six inches in height, is to take them up without breaking their tap roots and transplant in a warm, but shady, situation within three or four inches of each other, having the temperature nearly equal to that of the place from which they were taken, and to keep them moist and shaded until they start into growth. The same method must be applied to most species of our native trees in order to insure success in lifting. By the above method I

have had kauri pines grow six or eight inches the first season. New Zealand trees are invariably very difficult to acclimatize in other countries.

Timber is cut here for commercial purposes without any regard to the season of the year. The proper season is from April to September. There is also another consideration in felling timber, that is, never to cut it except in the first or last quarters of the moon. This may appear to be a very trivial matter in the estimation of most people, but if we bring science to bear on this perplexing question it will soon solve the problem. I have no doubt most of you are aware that the sap of an evergreen tree bordering on the tropics is continually in motion, excited more or less every lunar month in the year. The moon when near the full has a very great power of attraction. For instance, springs always run faster at full moon than at the change; it has also the same influence on the vegetable kingdom, for it is a well known truth that nature's laws are governed by one common whole applicable to all. If a tree be cut down either a week before or after full moon the timber will not be so durable or lasting as that which was cut near the change. This is a question which requires investigation because it affects the community at large. Timber if cut while the sap is in motion will not endure nearly as long as that cut when the sap is not so much excited, therefore I think it would be a matter of great importance to restrict the cutting of timber to certain periods of the year.

As the destruction of our forests is going on at a rapid rate, and no means are being taken to prevent it, if such destruction continues to increase for the next half century our forests will be well nigh exhausted. No landed proprietor who wants to leave a lasting inheritance to his children's children, and has the means at his command, ought to be without a plantation of New Zealand trees. Then any soil which is unsuitable for agricultural purposes might be turned to good account. The formation of plantations includes the inclosing, the preparation of the soil, and the mode of planting. First inclose the ground of the intended plantation with a strong fence, so as to exclude cattle; unless this precaution be taken it would be a waste of labour and property. Next in the preparation of the soil I would advise summer fallowing, so as to destroy all weeds and roots and leave the ground in a well pulverized state for the reception of the plants in the following winter. The most common mode is to plant promiscuously, not more than from seven to eight feet from plant to plant; but first plant a double row of rapid growing and hardy trees round the edge, the *Coniferæ* being the most suitable, as a means of protection against the wind. Within this boundary plant the following native trees: *Dammara australis* (kauri), *Podocarpus totara*, *Dacrydium cupressinum* (rimu), *Podocarpus dacrydioides*, *Phyllocladus trichomanoides* (tanekaha), *Fagus*, sp., (commonly called birch), *Vitex littoralis* (puriri), *Alectryon excelsum*,

Metrosideros robusta (pohutukawa), *Podocarpus spicata* (matai), *Nesodaphne taraire.* The above are a few of the largest forest trees, and those which are most useful as articles of commerce. There are many of the soft-wooded species which might be introduced with advantage, and also act as nurses to the hard-wooded varieties. It would also be advisable to intersperse among the trees at convenient distances a few of the hardy American or European pines, both for shade and shelter to the permanent trees. They can easily be cut out as the others advance in growth.

As regards the growth of our native trees it is very difficult to arrive at a given standard, because we have to take into consideration the soil, aspect, and situation. Trees of the same genera and species planted in opposite aspects, and in different soils, will not attain to the same growth in one year. In alluvial deposits trees make more growth in a given period than those planted on more exposed situations. About ten years ago I planted on rather a poor sandy soil a rimu and a lance-wood; the plants were about one foot in height, with very little protection; they are now both flourishing remarkably well, each being about twelve feet in height, so that they have on an average grown a little more than one foot each season since planted.

Dammara australis (kauri).—I have had young plants after being established grow about one foot in a season in a sheltered situation.

Podocarpus totara (totara) is about the best of all our New Zealand trees to establish, as it generally grows on the most exposed situations in the bush. I have had young plants after being established for one year make a growth of two feet the following season. The average growth is from twelve to eighteen inches. The totara does not require so much shade as many of the other varieties of native trees.

Dacrydium cupressinum (rimu).—The most graceful of the New Zealand trees, succeeds best in a rich but rather moist soil. Young plants in a sheltered situation make about one foot in a season.

Podocarpus dacrydioides.—A very lofty tree, 150 feet high; wood white, soft; grows in low swampy ground. Young plants are easy to establish, and grow about eighteen inches in a season.

Phyllocladus trichomanoides.—A slender tree, attaining a height of about sixty feet; wood white, close grained; not a very fast growing variety. Bark used for dyeing purposes.

Fagus, sp.—Lofty and handsome trees, attaining to a height of from 80 to 100 feet; well adapted for planting in higher altitudes. Young plants make a foot of young wood in a season.

Vitex littoralis (puriri).—A large and handsome tree, 50 to 60 feet high; trunk 20 feet in girth; wood very hard. The foliage is large, and of a beautiful bright green colour; flowers bright red. The flat symmetrical form

of the tree and the bright green foliage affords a pleasing relief to the landscape. Young plants average about one foot of fresh wood in a season.

Nesodaphne taraire.—A lofty and handsome forest tree, from 60 to 80 feet high; wood white; leaves three to six inches long. Young plants grow freely.

A lenthy discussion ensued in which Messrs. Stewart, Haultain, Kirk, Heale, Munro, and the author took part.

3. "On Shells collected North of the Auckland Isthmus," by T. B. Gillies.

This was an account of the terrestrial and fluviatile shells collected during the cruise of the "Glance," in 1868. So few facilities for naming shells of this kind exist in the colony that the author sent a series of specimens to Professor McAlister of Dublin, who had kindly favoured him with their identifications, which were now published for general information.

4. On the Botany and Conchology of Great Omaha," by T. Kirk, F.L.S. (See *Transactions*, p. 363.)

The author gave a sketch of the chief features of the locality with a catalogue of the marine, fluviatile, and terrestrial shells collected by him.

Sixth Meeting. 14*th October*, 1872.

T. Heale, President, in the chair.

New members.—A. Heather, W. C. Roberts, Owen Jones, J. Mason, J. W. Preece, Capt. J. Wilson, A. Sheath.

The monthly list of donations to the Library and Museum was read by the Secretary.

Capt. F. W. Hutton, C.M.Z.S., F.G.S., was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with clause 7 of the New Zealand Institute Act.

1. Mr. Kirk read a memorandum by Governor Weld on the jam tree (*Acacia*, sp.,) of West Australia, of which he had forwarded a parcel of seed through Dr. Hector for distribution in the province of Auckland.

2. "On the Fertilization of the New Zealand species of *Pterostylis*," by T. F. Cheeseman. (See *Transactions*, p. 352.)

3. "Notice of a Remarkable Arborescent Fern on Ngongotaha," by T. Kirk, F.L.S. (See *Transactions*, p. 347.)

4. On the Specific Characters of *Dicksonia antarctica*, Br., and *D. lanata*, Col.," by T. Kirk, F.L.S. (See *Transactions*, p. 345.)

5. "On a New Mode of Compiling Tables of Logarithms," by R. J. Pearce.

SEVENTH MEETING. *23rd December*, 1872.

His Honour T. B. Gillies in the chair.

New members.—G. Aickin, E. Gibbons, G. Fraser, W. Hay, A. Beetham, G. Kirton, W. Humphreys, J. Wilson, W. Ware, Lt.-Col. Nation.

The list of donations to the Library and Museum was read by the Secretary.

Mr. Gillies presented the original Ms. of a Maori poem, for the publication of which Mr. C. O. Davis was tried for sedition in 1865, and which might therefore be expected to become of historic interest.

Mr. Gillies called attention to a statement made by Dr. Hector in the fourth volume of *Transactions* (p. 379) respecting the first introduction of trout, from which it appeared that trout were first liberated in the North Island in November, 1871; the fact being that trout were first introduced into the North Island by the Auckland Acclimatization Society, and liberated near Auckland in October, 1870. He thought it possible that, unless corrected, this error might at some future day lead to misconception with regard to the rate of diffusion of this fish.

1. "Notes on Rurima Rocks," by Major W. G. Mair. (See *Transactions*, p. 151.)

The Hon. Col. Haultain corroborated the author's statement respecting the abundance of fish in the vicinity of the rocks.

2. "On the Mud Fish (*Neochanna apoda*), an extract from a letter written by G. G. Fitzgerald;" communicated by W. C. Roberts.

(ABSTRACT.)

The author noted that he had found several specimens of this curious fish, while trenching. A heavy rain fell, and on baling the water out he found three or four of the fish were left, which were thought to have fallen from the sky. The soil was only about six inches deep, the subsoil being very tenacious blue soil. The fish was found at least eighteen inches down in this clay, in a little chamber somewhat larger than its own carcase. The clay was damp, but there was no water about. The chamber was dry and completely shut in from above, a large root of a tree passing immediately over the spot.

3. "On the Mud-fish (*Neochanna apoda*); an extract from a letter written by S. E. Vollams;" communicated by W. C. Roberts.

(ABSTRACT.)

The author knew of this fish in the early days of Hokitika. The land where they were found was covered with the usual bush, and in rainy weather was always under water.

When the ground is cleared there is generally only a few inches of the top soil, and then from two to four feet of whitish blue clay, something like pipe-clay. This clay as it nears the shingle gives way to a gritty brownish coloured soil. At an average depth of four feet the shingle is reached, and is firmly held together by a rust-coloured cement. This shingle holds water to a depth of as much as six or eight feet. Below that a drift is reached which drains the water. A trench was cut about two feet wide into the shingle, completely separating a block of land except in floods, when the trench was filled and the land under water. About two years after the land was cleared the roots were grubbed up, and numbers of these fish were found in the soft clay. Some were very lively and others torpid, some showing a bright skin and some a foul slimy coat. The shape of the fish could sometimes be seen in the mud from which it had been dislodged. They are found in great numbers in making new roads through swampy land, but seem to disappear from the land on its being drained and cultivated.

Mr. Lodder remarked that he had collected a similar fish under stones on the banks of a fresh-water stream, near the anchorage ground for coal vessels, at the Bay of Islands.

Mr. Gillies stated that fish apparently similar, and which manifested the same dislike to fresh-water, had been obtained by Mr. G. B. Owen at a depth of several feet when sinking a well at Newmarket. He also drew attention to the interesting account of the mud-fish given by Dr. Hector in his Notes on the Edible Fishes of New Zealand.

4. "On a Remarkable Instance of Refraction of the Hakarimata and Taupiri Ranges," by Major W. G. Mair.

(ABSTRACT.)

On 1st June of the present year a remarkable instance of mirage or refraction was witnessed by a number of persons in Alexandra. A portion of the Hakarimata and Taupiri ranges, about ten miles in length, distant from thirty miles on the left to thirty-six miles on the right hand, and bearing from north-west to north, appeared to be lifted fully 1,000 feet into the air. At one moment it looked like a dark wall with a straight upper edge, and then it would suddenly be cleft open and present numerous gaps and peaks with castellated summits. The openings would increase gradually and then close again, after which flashes of light would appear in the face of the wall, and

gaps would again be seen, the transitions being so rapid that the eye could not follow them. At times the phenomenon would become as it were fixed, and no perceptible alteration could be noticed for the space of a quarter of an hour. The upper edge maintained the same level throughout, except when occasionally a clump of trees would be drawn up to several times their height.

5. Further Notes on the Nativity of *Polygonum aviculare*, L., in New Zealand; in reply to Mr. Travers," by T. Kirk, F.L.S. (See *Transactions*, p. 315.)

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

First Meeting. *6th March*, 1872.

His Honour Mr. Justice Gresson, President, in the chair.

The President delivered the following

ADDRESS.

Gentlemen,—

He who has to address *ex cathedrâ* persons who are much better acquainted with the subject than the speaker, must always find himself placed in an embarrassing position. Such is the position in which your kindness in electing me as your president has placed me this evening.

My first impulse was to decline the honour, solely from a conviction that many whom I address are much better qualified for the office than I am. But further reflection convinced me that in a new country like this he best discharges his duty towards the colony who, putting aside considerations of a personal nature, undertakes and performs to the best of his ability the task assigned to him by his fellow colonists. Moreover, he must remember that in a colony every person, however limited his acquirements, has more influence and consequently greater responsibility than he would have in an old and populous country.

I congratulate you on the progress which the society has made during the past year. The number of members continues to increase. Part of the income of the society has been devoted to the purchase of scientific works of reference, the want of which was much felt, and as several donations of books have been received from scientific societies, and from individuals, we already possess the nucleus of a library. If, in addition to this, we could obtain the Provincial Council library, from which at present the public derives but little benefit, we should have made some progress towards the acquisition of a library, which, if thrown open to the public, as has been done at Melbourne for years with most beneficial results, would confer a great boon upon the community.

You are aware that in February, 1871, an ordinance of the Provincial Council was passed, incorporating a Board of Trustees by the name of "The

Trustees of the Canterbury Museum and Library" for establishing a public library and a school of technical science, and for the safe custody of the books and other valuable property deposited in the Museum. In furtherance of the objects contemplated by the ordinance, a resolution was passed by the Provincial Council during its last session, for reserving 100,000 acres of pastoral land as an endowment. In addition to this valuable endowment we have to acknowledge the liberal gift of one of our members, Mr. Gould, who has ordered casts of statues of the old masters, which will not only be a source of much enjoyment, but will be most useful in furnishing models for a School of Design. Great advantages are already experienced from the enlarged space afforded by the new building for the contents of the Museum. The various objects of interest have been arranged and classified by the director, Dr. Haast, with great care, and with a view to their being used for advancing the cause of science. The collection is now a very considerable one, and contains many valuable specimens, including the complete skeletons representing seven different species of *Dinornis*. It has been the endeavour of the trustees to obtain type collections from the various centres of learning in the Northern Hemisphere, as these are exceedingly valuable for the purposes of teaching and study. Through the zealous exertions of Dr. Haast, the trustees have succeeded in obtaining such collections representing all orders and classes of Zoology. A microscope has been ordered, and also an aquarium, and a laboratory will soon become necessary. The number of visitors of all classes proves abundantly the interest felt by the public in the collection, which could not before be exhibited for want of space.

The enlargement of the building which the trustees are making through the liberality of the Provincial Council will afford rooms for the reception of the additions to the collections which are being received continually, and also for lectures on scientific and technical subjects, which we may hope will become general now that the New Zealand and Otago Universities have been established. The experiment is already being tried here by a course of lectures on Natural History delivered weekly at the High School by one of our members. The unflagging interest exhibited by the pupils, as well as by several other persons who are permitted to attend, proves that lectures on scientific subjects will be thoroughly appreciated. The great advantages that would result to the youth of the community from scientific and practical training have been truly and clearly stated by his Excellency Sir George Bowen, the President of the New Zealand Institute, and by the presidents of several of the affiliated societies; it is therefore unnecessary for me to dwell upon them.

Gentlemen, I congratulate you heartily on the proceedings which have lately been taken for the establishment of an observatory in this province.

Some of our members have had this object at heart for a long time, and the approaching transit of Venus made them the more anxious to take steps towards the accomplishment of their wishes. The 16th December being the twenty-first anniversary of the arrival of the Canterbury settlers was deemed a suitable time for moving in the matter. Accordingly, at a most influential meeting held on that day, resolutions were passed, and a committee appointed for carrying out the desired object. The committee has since had the satisfaction of learning that while the subject was under consideration here the Imperial Government was communicating with the Colonial Government at Wellington on the same subject, and suggesting Canterbury as the probable site, and that Dr. Hector is of opinion that Canterbury, from its position and climate, is the most suitable place for the observatory. In furtherance of the object the Provincial Council has voted a sum of £1,000 for the establishment of an observatory, and £200 for providing a suitable site, on condition that the Colonial Government will undertake the maintenance of the institution. A further sum of £200, contributed by subscribers, has been placed at the disposal of the Astronomer Royal, to be used by him as he may think expedient for promoting the object of the subscribers. We have good grounds for hoping that our efforts will be liberally supported by the Colonial, and perhaps also by the Imperial Government.

I need not point out the great advantages to the cause of science that must result from the establishment of an observatory, and from the residence amongst us of a professor whose observations and lectures would extend the knowledge of the oldest and grandest of the sciences, and who would moreover indirectly benefit the colony by bringing us into friendly relationship with other scientific bodies. Another very important consideration connected with the subject is the incalculable advantage that may be derived by our youth from having access at all times to means of information and assistance in the study of this most attractive science, comprehending as it does a knowledge of mathematics, without which no great advance can be made in that or any other of the higher departments of science.

The actual amount of work done during the session has not been large. Thirteen papers were read—some of them of considerable interest. I should be encroaching on the privilege of his Excellency Sir George Bowen were I to enter into a detailed consideration of these papers. They, as well as the papers read before the other affiliated societies, will, doubtless, be adverted to by his Excellency in his annual address. One of them, a very clear and practical paper, by Mr. Dobson, upon "The Influence of Railway Gauge upon the Constructive Cost and Working Expenses of Railways," will form a supplement to an interesting paper on "The Political Economy of Railways," by his Honour Mr. Justice Chapman, read before the Otago Institute, in

August, 1870, and published in the third volume of the *Transactions*. Another paper, by Dr. Barker, entitled "Continuous Creation *versus* Darwinian Evolution," evidently the result of much reading and thought, naturally excited a good deal of discussion, as it treats of a subject of the deepest interest, which at present engages the attention of some of the profoundest thinkers of the day.

Whatever opinion may be formed of the theory propounded by Mr. Darwin, most persons will agree that science is indebted to him for the facts which he has collected, and for the great amount of information which he brings to bear upon his subject, as well as for his candour and fairness in stating and supporting his views.

We must always bear in mind that two classes of workers are necessary for the advancement of science, namely, those who collect facts and those who deduce general conclusions from those facts. It has often been said that fact is worth more than theory, and it is of course true that the value of theory depends on the extent to which it is founded on fact—but both have important uses in the elucidation of truth. An ingenious theory, though not altogether sound, may be the means of attracting and setting to work minds of different schools of thought, and by the help of the light thus let in from various sources, truths may be arrived at which otherwise might have remained long undiscovered. To quote the eloquent language of Sir John Herschel, in his "Introduction to the Outlines of Astronomy," "No grand practical result of human industry, genius, or meditation, has sprung forth entire and complete from the master hand or mind of an individual designer, working straight to its object, and foreseeing and providing for all details. As in the building of a great city, so in every such project the historian has to record rude beginnings, circuitous and inadequate plans, frequent demolition, renewal, and rectification, the perpetual removal of much cumbrous and unsightly material and scaffolding, and constant opening out of wider and grander conceptions, till at length a unity and a nobility is attained, little dreamed of in the imagination of the first projector. * * * No man can rise from ignorance to anything deserving to be called a complete grasp of any considerable branch of science without receiving and discarding in succession many crude and incomplete notions, which so far from injuring the truth in its ultimate reception, act as positive aids to its attainment by acquainting him with the symptoms of an insecure footing in his progress. To reach from the plain the loftiest summits of an alpine country many inferior eminences have to be scaled and relinquished; but the labour is not lost. The region is unfolded in its closer recesses, and the grand panorama which opens from aloft is all the better understood and the more enjoyed for the very misconception in detail which it rectifies and explains."

No one need be debarred from joining our ranks from a consciousness of ignorance of scientific subjects. There are, of course, many amongst us who have been prevented by circumstances from acquiring scientific information, but all may be intelligent observers of the facts that come under their own immediate notice. It must be admitted that habit and mental training are of great value for the observation of facts, but there is no doubt that even uneducated men of ordinary intellect generally acquire a large amount of trustworthy information merely from observing the facts brought under their notice by their daily occupations. If only this faculty were more generally turned to account in the study of any one particular branch of science, according to individual taste, what a large amount of information would be accumulated.

We often hear complaints of the want of amusement and recreation in the colony, and this is sometimes advanced as an excuse for the indulgence in low and sensual gratification to which young men here often become addicted. If they would only open their eyes to the wonderful phenomena by which they are surrounded, and would choose a subject of observation, botany or geology for example, they would not only bring valuable contributions to the cause of science, but they would find fresh sources of interest constantly opened up to them, and their enjoyment of life multiplied and enhanced.

It has been well said that "the earnest naturalist is pretty certain to have attained that great need of all men, to get rid of self. He who after the hours of business finds himself with a mind relaxed and wearied will not be tempted to sit at home dreaming over impossible scenes of pleasure, or to go for amusement to haunts of coarse excitement, if he have in every hedge, bank, and woodland, and running stream, in every bird among the boughs, and every cloud above his head, stores of interest, which will enable him to forget awhile himself and man, and all the cares, even all the hopes of human life, and to be alone with the inexhaustible beauty and glory of nature, and of God who made her.

The admirable paper of Mr. Potts, "On the Birds of New Zealand," published in Vols. II. and III. of the *Transactions*,* affords one of the many striking examples contained in those volumes of how much valuable information may be acquired by habits of intelligent observation.

In reading the biographies of eminent men—Bunsen, for example—one cannot fail to observe how much their objects of interest in life are multiplied by the wise direction of their mental activity. This observation applies with increased force to the life of colonists, who, from their isolated position, are liable to become absorbed in their own petty interests, and to form narrow opinions of what is passing beyond the sphere of their own personal observa-

* See also Art. XX., p. 171.

tion. It will perhaps be objected that in a colony the daily tasks of life leave men little leisure for intellectual pursuits; but some of the busiest men have been eminently devoted to science and literature: witness Lord Bacon, and in our times Lord Brougham, the late Lord Derby, Mr. Gladstone, and many others. The fact is that such men resort to science and literature as a recreation, and the change from the active business and contests of life is found to be a refreshment. Until lately we could only look back with regret at the educational advantages which we seemed to have forfeited by leaving our homes. Happily we may now congratulate ourselves on the advancement which has been made here towards providing facilities for obtaining a superior education. However our legislators may differ on the subject which is exciting so much agitation in England as well as here, as to whether national education should be denominational, unsectarian, or secular, all are agreed that the utmost facilities should be afforded for educating the youth of both sexes and of all classes. The apathy on this subject which at first prevailed, and which was perhaps not unnatural, considering the difficulties which the early settlers had to encounter, has given place to an earnest desire, not only to place general education within the reach of all, but also to open the way, by scholarships and other inducements, for those who are desirous of advancing to the higher branches of science and literature.

Independently of the value of knowledge for its own sake, to which I have very inadequately adverted, there never was a time when eminence in science, literature, or art, was more appreciated or more amply rewarded than now. Among the many instances which will occur to you as immediately within our own time, I need only mention the names of Humboldt, Herschel, Faraday, Murchison, Playfair, Niebuhr, Carlyle, Tennyson, and Landseer. Such men are not only claimed with pride by their own countrymen, but are admired and welcomed by the most gifted men of every civilized nation.

Although I fear I have already occupied too much of your time, I am unwilling to conclude my address without saying a few words upon a subject which seems to me of very great importance. Until lately an impression, more or less general, prevailed, that the tendency of the study of science was to lead men to conclusions at variance with revelation. This fallacy is well nigh exploded, and it is indeed singular that it should ever have been supposed that anything in nature could be at variance with the revelation which proceeded from the God of nature. If the student of science should meet with difficulties which he may be unable to reconcile with God's word, surely it would be more reasonable to attribute them to his own limited and imperfect conceptions of truth than to conclude that they are irreconcileable. We do not really know the cause of anything in nature. We only know that

certain events are, so far as our experience goes, invariably succeeded by certain other events, which we popularly call consequences.

He who has studied the amazing grandeur and perfect order of the heavenly bodies disclosed by the telescope, and has, by the aid of the microscope, observed the construction of even the lower forms of organic life and the laws by which they are regulated, must have used his intellect and reason to very little purpose if he be not overwhelmed with feelings of reverence and awe for the Creator, who, at the same time, rules a universe so vast that but a small portion of its space can be comprehended by our imperfect intellects, and forms his minutest objects so delicately that their organization is incomprehensible to our grosser faculties.

A conversazione was then held, numerous objects of interest, and philosophical apparatus, microscopes, etc., being exhibited by members.

Second Meeting. *3rd April*, 1872.

W. B. Bray, Vice-President, in the chair.

New members.—G. B. Parker, M.H.R., W. M. Maskell.

Books presented since last meeting were laid on the table.

1. "On Darwin's Provisional Hypothesis of Pangenesis," by A. C. Barker.

2. "Note on the Size and Weight of the Smallest Particles visible to the Highest Powers of the Microscope," by Ll. Powell, M.D.

A discussion ensued in which several members took part.

Third Meeting. *1st May*, 1872.

His Honour Mr. Justice Gresson, President, in the chair.

Donations of books received since last meeting were laid on the table.

1. "On the Spiders of New Zealand; Part I., Genus *Salticus*," by Ll. Powell, M.D. (See *Transactions*, p. 280.)

2. "Notes on the Stridulating Organs of the Cicada," by Ll. Powell, M.D. (See *Transactions*, p. 286.)

FOURTH MEETING. *5th June*, 1872.

W. B. Bray, Vice-President, in the chair.

New member.—John Beattie Gresson.

1. "Remarks on some Birds of New Zealand," by Otto Finsch, Ph.D. of Bremen, Hon. Mem. N.Z. Inst. (See *Transactions*, p. 206.)

FIFTH MEETING. *3rd July*, 1872.

His Honour Mr. Justice Gresson, President, in the chair.

New members.—T. G. Wright, Marmaduke Dixon, T. W. Hall.

Presentations of books were laid on the table.

The Rev. C. Fraser read a short pamphlet by Professor Agassiz, being a forecast of the nature of the fauna which will be probably brought to light by the projected deep sea exploration.

SIXTH MEETING. *7th August*, 1872.

His Honour Mr. Justice Gresson, President, in the chair.

New member.—T. D. Condell.

1. "Notes on some Undescribed Fishes of New Zealand," by Julius Haast, Ph.D., F.R.S. (See *Transactions*, p. 272.)

2. Dr. Haast read a letter from Professor Airy concerning the proposed expedition to New Zealand to observe the transit of Venus in 1874, with his answer thereto.

3. Mr. Fereday read for Mr. Inglis a letter from Professor Agassiz on deep sea dredging.

SEVENTH MEETING. *4th September*, 1872.

W. B. Bray, Vice-President, in the chair.

New member.—Thomas A. Phillips.

The following presentations of books were laid on the table:—"Erebus and Terror" (Zoology), from Dr. Gray, F.R.S., and "Etchings of Mollusca," from Mrs. Gray, and a vote of thanks was passed to the donors.

1. "On the Practical Uses of an Observatory," by W. M. Maskell.

This paper was printed by resolution of the Council of 2nd October in the "Lyttelton Times."

2. "Remarks on the *Coleoptera* of Canterbury, New Zealand," by C. M. Wakefield. (See *Transactions*, p. 294.)

3. "On *Phalacrocorax punctatus* (Spotted Shag)," by T. H. Potts, F.L.S. (See *Transactions*, p. 201.)

EIGHTH MEETING. *2nd October*, 1872.

His Honour Mr. Justice Gresson, President, in the chair.

New member.— — Armson.

Publications received since last meeting were laid on the table.

ANNUAL GENERAL MEETING. *6th November*, 1872.

His Honour Mr. Justice Gresson, President, in the chair.

ANNUAL REPORT.

The Council congratulate the members of the Society on the completion of the eighth year since its first establishment. The Society has now a firm footing, and its future welfare is no longer a matter of uncertainty. The Council would, however, point out that, although the number of subscribers is as large as ever, there has been during the past year a dearth of papers and communications, which may cause the Society to be compared unfavourably with the other affiliated Societies on the appearance of the *Transactions* of the New Zealand Institute. They would therefore urge upon the members the necessity of each one endeavouring to contribute information during the next session of the Society, and the Council beg to suggest that the Society is the proper medium for publishing much valuable information which is at present forwarded to newspapers and English periodicals.

Nine papers have been read during the past session.

Numerous gifts of books have been received during the year.

A marine aquarium constructed of slate and plate-glass in the best method, and to contain 15½ gallons, has been obtained from home, and will shortly be stocked and placed in the Museum, where it will undoubtedly prove highly attractive.

A grant of £5 has been made to assist Dr. Haast in his explorations in the Moa Bone Cave at Sumner.

£10 has been voted for the purchase of certain German works recommended by Dr. Haast and Dr. Powell.

Though without their province, the Council cannot pass by without comment the strenuous efforts which are being made by the Collegiate Union, School of Science, and other educational bodies, to provide a higher education for the youth of the province by the establishment of a University College, and they think that the Society should use all the influence it possesses to further the endeavour.

The number of members is now eighty.

The total amount of receipts for the past year was £127 12s. 1d., and the expenditure £104 4s. 7d., of which the amount of £20 16s. 1d. was expended on books and an aquarium. The balance in hand is £23 7s. 6d.

Election of Officers for 1873.—President, H. J. Tancred; *Vice-Presidents*—T. H. Potts, F.L.S., Robert Wilkin; *New Members of Council*—Mr. Justice Gresson, Dr. A. C. Barker, W. Montgomery *vice* J. W. S. Coward, J. S. Turnbull, and J. F. Armstrong retired. *Hon. Treasurer*—J. Inglis; *Hon. Secretary*—C. M. Wakefield.

Resolved on motion of Mr. Carruthers—That in order to give effect to the recommendation of the Council a committee be appointed, consisting of his Honour Mr. Justice Gresson, Messrs. H. J. Tancred, W. B. Bray, Dr. Powell, and the mover, to draw up a petition to the Provincial Council and his Honour the Superintendent, praying them to take steps for the establishment of a University College in Canterbury.

Extra Meeting. 12*th December*, 1872.

Julius Haast, Ph.D., F.R.S., in the chair.

1. "On the Birds of New Zealand, Part III." by T. H. Potts, F.L.S. (See *Transactions*, p. 171.)

2. "On the Direct Injuries to Vegetation in New Zealand by various Insects, especially with reference to Larvæ of Moths and Beetles feeding upon the Field Crops; and the Expediency of introducing Insectivorous Birds as a Remedy," by R. W. Fereday, C. M. Ent. Soc. Lond. (See *Transactions*, p. 289.)

OTAGO INSTITUTE.

FIRST MEETING. 12*th March*, 1872.

R. Gillies, Vice-President, in the chair.

New member.—Charles Rous Marten.

1. "Observations on the Zodiacal Light, tending to show its Connection with the Sun's Motion in Space," by H. Skey. (See Appendix, p. xliii.)

2. "On the Taieri Floods," by G. M. Barr. (See *Transactions*, p. 111.)

ANNUAL MEETING. 22*nd July*, 1872.

T. M. Hocken, M.R.C.S.E., Vice-President, in the chair.

New members.—Professor Black, M.A., D.Sc., A. Fleming, M.D., G. M. Thomson, John Hardy, Thomas George, James Fulton.

ABSTRACT OF ANNUAL REPORT.

The Council, in presenting its annual report, is again able to congratulate the members of the Society on its steady progress. Twelve papers have been read during the last year, several of which have been printed in the fourth volume of the *Transactions* of the New Zealand Institute.

An order for books to the value of £20 has been sent home, and at the same time a spectroscope of high class, to cost about £50, was ordered.

Arrangements have also been made for the transmission of a further order for books to the amount of £45.

The library of the Society has received valuable presents from the Smithsonian Institution at Washington, the Museum of Comparative Zoology of Harvard College, the Trustees of the Public Library at Melbourne, and from Mr. Justice Chapman.

The total receipts for the year amounted to £139 3s. 11d., of which £79 11s. 6d. was received as subscriptions, and the expenditure to £140 13s. 11d., but £115 of the amount set down as expenditure has been transferred to the Library Fund. Out of this £70 has been spent on books and a spectroscope.

The Field Naturalists' Club, initiated at one of the meetings of the Society, has been actively at work during the past season, and a report of its proceedings has been prepared by Mr. P. Thomson, the Honorary Secretary of the Club.

Election of Officers for Year Ending 30th June, 1873 : *President*—His Honour Mr. Justice Chapman; *Vice-Presidents*—Rev. Dr. Stuart, J. T. Thomson, F.R.G.S.; *Council*—Professor Black, M.A., D.Sc., Professor Shand, M.A., Dr. Deck, T. M. Hocken, M.R.C.S.E., R. Gillies, H. Skey, P. Thomson; *Hon. Treasurer*—J. S. Webb; *Hon. Secretary*—D. Brent, M.A.

1. "On Barata Numerals," by J. T. Thomson, F.R.G.S. (See *Transactions*, p. 131.)

2. "On Local Variations of Atmospheric Pressure dependent on the Strength of Winds," by J. S. Webb. (See *Transactions*, p. 106.)

A collection of plants from Auckland, presented by Mr. T. Kirk, F.L.S., was laid on the table, also a collection of ferns made by Mr. P. Thomson during the past season.

Third Meeting. 18*th August*, 1872.

His Honour Mr. Justice Chapman, President, in the chair.

The President gave the following

ADDRESS.

We meet this evening to inaugurate the fourth year of the Otago Institute. And first, I have to thank you for again electing me President. At the same time, you must permit me to suggest that this office should not be permitted to devolve, as of course, continuously on the same individual. The infusion of new blood is salutary to an institution like this. Many of our members are more masters of their time than I am, and on several occasions, when I have especially desired to attend the meetings of the Society, I have been prevented either by absence at the Court of Appeal or on circuit, or by my engagements here. There are also many members of scientific attainments, whose election to the office of President would tend to promote the success of the Society. I therefore hope that at the election of officers for the year 1873–74 your choice will fall upon some worthy successor.

The constitution of this Society, and of others of a similar character in close union with the New Zealand Institute, seems to me to be highly favourable to the promotion of science. Taking our own Society alone, it provides for the free interchange of the scientific knowledge and scientific thought possessed

and capable of being communicated by each and all of the members. It also furnishes the wholesome stimulus of emulation and friendly competition. It has another advantage, apart from science—its primary object. It has a social usefulness. It brings together, in friendly social intercourse, men who from their private engagements and pursuits, or remoteness from each other, might never otherwise have an opportunity of meeting. The New Zealand Institute performs for the several societies united with it, that which each society does for its own members. It makes common property of the contributions of all. Whatever is useful in the deliberations and proceedings of one is thrown into the common stock, with a salutary power of rejection and selection. The four volumes of *Transactions* bear witness to this. No one society, howsoever able its members, or howsoever liberally supported, could have produced such a valuable body of scientific information as we find in the volumes to which I have alluded. Nor could all the societies, working independently, have done so. The mere pecuniary economy of the present arrangement is a source of efficiency which no amount of isolated energy could attain. All share in the liberality of the Legislature. The power of selection, too, to which I have alluded, which involves rejection, has imparted to the *Transactions* a character which has called forth commendation from the scientific bodies of other countries.

A few words upon the history of these institutions will, I trust, be deemed not out of place. The first attempt to establish a scientific body in New Zealand was the New Zealand Society in 1851. Its chief promoter was Sir George Grey. It had about seventy members, and I had the honour of being one of its vice-presidents. Among the members were several gentlemen of scientific attainments, and others not unversed in literature. I may mention the names of the late Mr. Swainson, the well-known naturalist; Mr. Walter Mantell, a geologist by descent; Dr. Sinclair, an accomplished botanist; Dr. Ralph, a skilful microscopist; and there were others. At that time, however, the whole colony contained only about 32,000 Europeans—scattered over the whole length and breadth of the two islands; and it cannot be matter for surprise that the society, though well intentioned, languished; and, I believe, after a few years died what must be deemed a natural death. But let us be grateful to it, as the precursor and germ, and perhaps even the suggester of the existing well-established Institute.

The New Zealand Institute owes its existence to the "New Zealand Institute Act, 1867." The geological survey of the country is very wisely one of the principal objects connected with the Institute, and the Governor is empowered to appoint a manager of such survey, and also assistants. Branch societies may be incorporated with the Institute, and when so incorporated each Society elects a member to vote for the elected governors. Practically

this gives to each Society a voice and influence in the Institute. Although I cannot but lament the loss of Dr. Hector to this province, I think that those whom I am now addressing will rejoice that so able and accomplished a man has been secured as the animating spirit of the New Zealand Institute. Of his scientific attainments no one has any doubt; but it is not all who are aware how well fitted he is to direct the affairs of the Institute, by his genial nature, his equanimity, and his cheerful readiness to assist those who are in search of scientific knowledge. The *Transactions* bear witness to his firmness, discrimination, and skill as an editor.

The Wellington Philosophical Society, which from its locality has a closer connection with the Institute than more distant societies can have, numbers among its members several men of high scientific attainments, nor is any one of the societies destitute of members capable of making valuable contributions to the common stock of scientific ideas. Sir George Bowen, the Governor, has directly promoted the success of the Institute, and indirectly that of the affiliated Societies, by his zeal and especially by his encouraging addresses.

When the New Zealand Institute Act was passed in 1867 several local societies were in existence, doing yeoman service no doubt, but limited in their range of usefulness by the feebleness incidental to local effort. The New Zealand Institute imparted to them a new character; and the service was mutual, for without them the Institute itself would have been a mere incorporeal entity—but little better than a phantom. In June 1868—the year after the passing of the Act—the Wellington Philosophical Society and the Auckland Institute were incorporated with the New Zealand Institute, and in October of the same year the Philosophical Institute of Canterbury and the Westland Naturalists and Acclimatization Society followed. By this solid and compact union, the New Zealand Institute became what the French call *un fait accompli.* From my connection with the old Society of 1851, and from my previous intercourse with Dr. Hector, I naturally felt a strong interest in the new Society. Its constitution seemed to me to be sound—an opinion fully borne out by results; and as there was then no similar body near my own home, I at once joined the new Society. Our own Society did not long lag behind its predecessors. The Otago Institute dates from July, 1869, under the presidency of Mr. Justice Ward, and on my return from Europe in 1870 I found it in full vigour. In January, 1871, the Nelson Association for the promotion of Science and Industry was established, under the presidency of Sir David Monro. Both these Societies were at once incorporated with the Institute, so that at this time the New Zealand Institute may be characterized, not by perfect resemblance, but by analogy not very remote—as a quasi-University of Science, composed of five scientific colleges, with a general resemblance to each other, and yet with sufficient variety in their objects to

impart vigour to the whole, and render profitable interchange of thought between them more practicable than it would be among isolated bodies all cast in the same rigid and unvarying mould.

Hitherto the attention of all these societies has been directed principally, but not quite exclusively, to what are called the natural or physical sciences. Of these, undoubtedly geology and her twin sister mineralogy are of the greatest importance to us. New Zealand is especially rich in mineral resources —gold, iron, and other metals, and coal. Unscientific enterprise may develope, and indeed has developed these resources to a considerable extent; but they are capable of being rendered available with immeasurably greater rapidity, if energy be directed by scientific knowledge. Now all science is susceptible of two distinct kinds of progress. First, there is the improvement and development of science itself—the increase of the sum total of scientific knowledge; and, secondly, the extension of the existing stock of scientific knowledge, be it great or small, among those who may reap practical benefit from it.

One of our poets has said—

> "A little knowledge is a dangerous thing,
> Drink deep or taste not —."

No doubt, full, accurate, and exhaustive knowledge is better than the poet's little knowledge, but practically a little knowledge is better than no knowledge at all; and although superficiality is to be avoided, yet the communication of even a little knowledge, if that little be sound in itself, is in the highest degree useful. The miner works with more certainty, and with less risk of failure, if armed with even a small amount of geological and mineralogical science, provided that the little which is imparted to him by the man of science be accurate. The farmer, too, without aiming at being a great chemist, is saved from many disappointments by even a "little knowledge" of that department of chemistry which treats of soils and the food of plants. Other industrial pursuits are capable of being similarly aided. I was therefore not sorry to see that the youngest of our Societies—that of Nelson—makes the promotion of industry one of its objects, coupling it with the promotion of science. If the *Transactions* be extensively read they cannot fail to promote the second mode of extending science, and the press throughout the country has a useful function to perform by extracting such portions of our *Transactions* as may be of practical utility to the miner, the farmer, and other developers of the natural resources of the country.

But the natural or physical sciences do not exhaust what is comprehended in the word science; and our field seems to me to be of much wider extent. There is a science in every department of human knowledge; even our manly English sports have their science; that is, their operations are referred to principles and reduced to rules. Niebuhr has taught us that there is a science

of historical criticism. Look at our best modern histories as compared with the dry chronicles of the middle ages. The historian now dives into the springs of human action, he applies a rigid criticism even to the facts previously accepted as historical, and he arrives at conclusions with a degree of moral certainty unattainable in early times. The early history of the native race of New Zealand is not unworthy of the labours of the critical historian; their traditions are worthy of being collected and critically examined upon recognized principles which constitute the science of history. The language of the Maori proves beyond all doubt that he is a member of the widely-spread Polynesian family. His own tradition points to Hawaiki as the place whence he came, and Hawaiki is no more than a linguistic variety of the name Hawaii, and the two languages have no more differences than are capable of being accounted for by Grimm's law. Philology is now copiously applied to the testing of traditions. This Society has already contributed something to the common stock under this head, in the most interesting paper by Mr. J. T. Thomson, printed in the fourth volume just issued. But we in Otago are too remote from the great seats of the Maori population to be favourably situated even for the collection of facts. The northern societies, however, have the facts at their very doors, and I cannot help hoping that the attention of some members of those bodies will be directed to the subject before it becomes too late.

There is another subject, or rather class of subjects, quite within the province of this Society. I mean the science of language generally, and the science of each particular language, and especially of our own mother English. Much has been done of late years in Europe in these departments of science. Max Müller has produced two interesting volumes of lectures on the Science of Language, and he has, I think, succeeded in showing that there is such a science generally, without reference to particular languages except for purposes of illustration. Writers in the present century—Grimm in German ("Geschichte der Deutschen Sprache"), and Littré in France ("Histoire de la Langue Française"), Latham in England ("The English Language"), and Marsh in America ("Lectures on the Origin and History of the English Language"), have all treated their respective languages more or less scientifically. Until the present century there were very few dictionaries which were anything more than collections of words with fancied etymologies, which were often misleading and sometimes false. The dictionary of the French Academy, the Italian *Vocabolario della Crusca*, and even our own Johnson's dictionary, all fall short of the requirements of the present state of philological knowledge. The great German dictionary of Grimm, the French dictionary of the learned Littré, and the new English dictionary of Latham, are of a much higher character.

It is of course our own speech which is of the most importance to us; and with a few exceptions, at distant intervals, it is only recently that it has been philosophically investigated. This has been much aided by the recent revival of the study of Anglo-Saxon, which is really English in its oldest form. To take part in these investigations, with the hope of adding something to the common stock of knowledge, is certainly not inconsistent with the general scope and objects of these societies; and be it observed that the wider the field which we embrace the more do we place ourselves in communion with the scientific and learned bodies in Europe and America.

In England, France, and the United States, each science has its distinct society. Geological societies, geographical societies, botanical societies, antiquarian societies, philological societies, historical societies, and many others, are to be found in all the countries of Europe and America. We are far too young, and our population is too small and too much divided for such a division of scientific labour. The Institute is a happy expedient for securing all the advantages of association which our circumstances admit of, and this principle of union for scientific objects is not without example in England, where it is less needed than with us. The British Association for the Advancement of Science is of this catholic character, and there is a certain correspondence and connection (I am not sure whether I should be justified in calling it affiliation) observed between some of the metropolitan societies and provincial societies which pursue the same objects. The Royal Society of Antiquaries, for instance, has some such connection with various local antiquarian societies; so that the principle of our Institute is recognized as sound by those societies which have more experience than we have. What the French call *l'esprit d'association* is in fact one of the characteristic features of the present age.

I have alluded to the two kinds of progress of which science is susceptible; and let it never be forgotten that if in our humble beginning we should add but little, or even nothing, to the increase or improvement of science, extension and diffusion are within our reach. But may we not also hope to add something to the general stock? Let me say a few words to encourage hope, and stimulate exertion in that direction. Great and successful examples cannot fail to animate hope in those who are laudably ambitious of scientific attainments, and of making some contribution to the common fund.

One of the grandest discoveries of modern times—perhaps the most remarkable discovery of science ever achieved—was effected simultaneously by two mathematicians but little known at the time. I allude to the discovery of the planet Neptune. This planet was literally discovered before it was seen, by two scientific men acting entirely without concert. These men were known rather as skilful mathematicians than as astronomers. They

were Leverrier, of Paris, and Adams, of Cambridge. The planet Uranus had been discovered by the elder Herschel in 1781. During the ensuing half century its orbit had been observed and calculated and recalculated over and over again. Its theoretical orbit is of course an ellipse, but its actual and observed orbit differs from its theoretical orbit, that is, its orbit as it ought to be is found to be disturbed or perturbed. These perturbations, as they are called, were accurately observed and recorded not only by Herschel himself but by hosts of astronomers in all parts of Europe. Now all except a fraction of these perturbations were capable of being accounted for and laid down with precision, as caused by the attraction of Saturn and Jupiter. The combined influence of the smaller planets—Mars, the Earth, Venus, and Mercury—was so small as to be left out of account; for, besides their immense distance from Uranus, the size of the Earth as compared with that of Jupiter is about that of a pea to a moderate-sized orange. But it was found that after giving due effect to the attraction of Jupiter and Saturn—which could be exactly estimated—there remained certain perturbations still unaccounted for; and it was conjectured that these might be due to some unknown planetary mass far beyond the orbit of Uranus. Leverrier and Adams, unknown to each other, imposed each upon himself the gigantic labour of determining the place of this unknown planetary mass, by inference from the known and accurately recorded perturbations. The converse process was familiar to mathematical astronomers, that is:—Given the mass and density of a planet, and its distance from the affected body, the perturbation could be found. But no one, I believe, before their time had had the courage to grapple with the problem:—Given the perturbation of the affected planet, what is the place of the unknown disturbing body? However, after labour which is almost incomprehensible to persons not in some degree familiar with such calculations, Adams and Leverrier both came to nearly the same conclusion at the same time, the difference between the two results being very trifling.

In September, 1846, Leverrier wrote to Dr. Galle, of Berlin, announcing the result at which he had arrived, giving him the heliocentric longitude of the supposed planet for the 23rd September, and requesting him to look for the disturbing body in or near the place pointed out. On the 23rd September Dr. Galle, assisted by M. Encke, discovered what then appeared to be a star of the eighth magnitude very near the place indicated; but either from its distance or from the insufficient power of the instruments it did not exhibit a defined disc, so as to enable the observers at once to determine its planetary character. There was, however, no star in that place in the most recent catalogue. Star or planet was a question which could not be solved at once, and Galle had to wait until the following night with what patience he could. Then, indeed, the newly discovered body had moved in its orbit, and its true

planetary character was placed beyond doubt. Subsequent observations have proved that it is to this planet, since called Neptune, that the perturbations already mentioned must, according to the Newtonian law of gravity, be assigned. This narrative is calculated to stimulate the study of science. It shows what human perseverance governed by science can effect. Not that it is given to many men to discover a planet or a star; but science has numerous fields of inquiry which are open to the aspiring student, and in which every one may hope to discover something new and useful to his fellow men.

Scarcely inferior to this as a scientific discovery by the mere force of reasoning, and superior in practical results, is that which is described by Tyndall in one of his admirable lectures, namely, the discovery or rather invention of the barometer, which was arrived at by a process of scientific reasoning. It grew out of the common pump. About 1632 the Grand Duke of Tuscany was desirous of improving the public gardens of Florence, and in order to raise water to a considerable height he ordered some large pumps to be made. When they were set to work it was found that the water would not rise above 32 feet. What could be the cause of this? The hypothesis then current was, that nature abhorred a vacuum. Had her supposed abhorrence a limit? The problem was submitted to Galileo, but he was then in an ill humour in consequence of the persecutions of the Church for his heretical and unscriptural doctrine that the earth moves round the sun, and he answered sulkily that he supposed that nature only abhorred a vacuum up to 32 feet. The real meaning of his answer was that he was unable to solve the problem. But it was taken up by his pupil, Torricelli. He assumed that the water could not move up the exhausted cylinder of the pump without the application of some external force, and he conjectured that that force was the weight of the column of the atmosphere. Galileo had previously proved that air is not destitute of weight. Torricelli then reasoned thus: If the weight of the atmospheric column be the exact equivalent of the weight of 32 feet of water, then, inasmuch as mercury is about thirteen times as heavy as water, the column of air ought to support about 30 inches of mercury. This grand scientific conception being once generated the proof was easy. Torricelli took a glass tube about three feet long, closed—that is, hermetically sealed—at one end; into the open end he poured mercury until it was full, then closing the orifice with his finger or thumb he inverted the tube and plunged his hand into an open basin of mercury, upon the surface of which the external air could freely act; he then removed his hand, and you may judge of his delight when he found that the mercury fell to about 30 inches and there stopped.

This experiment was soon followed by another, which confirmed Torricelli's theory (if indeed it needed confirmation). The French philosopher, Blaise Pascal, reasoned thus: If Torricelli be right, if the water in the pump and

the mercury in the tube be equally supported by the weight of the atmospheric column, then, as we decrease the height and weight of that column, by ascending a mountain, the mercury ought to fall. Accordingly, he ascended the Puy de Dôme, taking with him what we may now call a mercurial barometer, which he found to fall as he ascended, and rise again as he descended, with perfect regularity.

Now, although we cannot hope to match the grand discoveries which I have just described, let this Society and others connected with the New Zealand Institute comfort and animate themselves with the reflection that we enjoy as the scene of our operations a new country and a comparatively unexplored field; and not only may we add materially to the common stock of scientific knowledge, but we may exercise a much more useful function—we may each in our humble sphere of life aid in the extension and diffusion of scientific knowledge among those who by their practical skill are best able to turn it to profitable account.

Another word of encouragement to those who are actively engaged in the ordinary business of life. The highest attainments of science have not been confined to those who have devoted themselves exclusively to scientific pursuits. Merchants, bankers, clergymen, lawyers, musicians, medical men—actively engaged in their respective professions and callings—have rendered themselves eminent in science by study during their hours of leisure. Lord Bacon, a lawyer and Lord High Chancellor of England, is considered the founder of the inductive philosophy, the true method of "interrogating nature," to use his own expression. David Ricardo, author of the "Principles of Political Economy and Taxation," was an active and successful member of the Stock Exchange. Thomas Tooke, the author of the "History of Prices," and a scientific writer on currency, was a Russian merchant, and at a time, too, when merchants had a prejudice against the science. George Grote was a banker when he commenced his truly philosophical "History of Ancient Greece," and became an active member of Parliament during the progress of his work. John Stuart Mill, when he wrote his admirable "System of Logic, Ratiocinative, and Inductive," and his "Principles of Political Economy," was a laborious officer of the East India Company. It is only his recent works that can be considered as the fruit of "a learned leisure." His philosophical works are enough for a long life of thought, and yet between thirty and forty years of that life were occupied in a laborious and responsible office. The power-loom was invented by the Rev. Edmund Cartwright—a country clergyman. The great bell at the New Houses of Parliament was planned, and the casting thereof superintended, by a barrister and a clergyman—E. Becket Denison and the Rev. W. Taylor; and it is a curious coincidence that the first bell ever cast in England was cast by Turketel, a monk, Chancellor to

the Saxon King, Edmund the Elder. Another barrister, Benjamin Rotch, was the inventor of the patent fid, now universally used in ships for securing topmasts; and to descend to smaller things, but still with a scientific element, another barrister, whose name I forget, was the inventor of a machine for making coffee—scientific in its principle, simple in its contrivance. The safety-valve of the steam-engine, or rather the mode of rendering it self-acting, is said to have been invented by an idle boy to save his own labour.

The great astronomer, Sir. W. Herschel, was by profession an organist. Music was the business of his life, astronomy his recreation, until in process of time they changed places. Grove, the author of one of the most profound and able works of modern science—an "Essay on the Correlation of Forces," a work which ranks side by side with the scientific writings of Tyndall and Huxley—was a practising barrister, then a Queen's Counsel, and is now one of the Judges of the Court of Common Pleas at Westminster. It will be obvious therefore that not one of the ordinary pursuits of active life is inconsistent with the prosecution of science. All such active pursuits afford some hours of leisure. There is a conventional "day's work" in all occupations, and when the mind once becomes habituated to healthy activity, inaction becomes unendurable and we naturally crave some new occupation for our hours of leisure. To all such craving spirits this Society offers comfort and help, co-operation and encouragement.

Mr. J. S. Webb said that the President's address was remarkably appropriate, in having brought into notice some things which it was necessary that some one with authority should mention. He knew that there were many gentlemen among them competent to take part in those meetings, who had all along kept back too much. This was owing, he thought, in the first place to the fact that they fancied something great was expected from them, forgetting that they appreciated any honest effort to impart knowledge and increase the common stock when they themselves were the recipients, and failing to deduce from that fact that their own efforts would be received with thankfulness, and that the smallest effort would have its value. In the second place, they forgot that the object of the Society should be to diffuse knowledge as well as to seek after the production of original matter. There were a great many whom he knew, both present and absent, who could put together the knowledge they possessed, and impart it in a manner which would be very pleasing to the members, and which they would be very thankful for. He himself proposed at their next meeting to set a good example by endeavouring not to impart anything original, but to gather together information, not to be found in text books, etc., respecting the recent progress of some branches of science. He hoped to find the experiment successful in drawing from his fellow members similar efforts.

Mr. Robert Gillies thought that if their meetings were to partake more of a conversational character, probably more interest would be taken in them. He felt very much interested in the remarks made by the President with reference to the science of language, and the enormous strides it had made since it was started. There could be very little doubt that it would in future greatly revolutionize their ideas with regard to many things in the world. With reference to this branch of science, he came across a statement which might not have come under the notice of members of the Society. They were all aware that the Indo-European languages had mostly two bases, which were termed the Turanian and Semitic. The Semitic languages had undergone a searching investigation, but hitherto all attempts to trace the foundation of the Turanian line had to a great extent failed. A short time ago he read a report of an address delivered by the Professor of Japanese in the Paris University. In that address the Professor stated that in the Japanese language were to be found the germs of the Turanian language, which had been so long sought for.

1. "On a fish of the genus *Bovicthys,* caught near Dunedin," by J. S. Webb.

(ABSTRACT.)

Bovicthys, sp.

Dorsal, 8—19; anal, 15.

Head three times in length, and four times diameter of eye; inter-orbital channel one-third of same; base of first dorsal less than half that of second; pectorals reaching to anal.

Upper surface light brown with olive blotches, and dull white patches on the sides; white beneath.

Stomach contained crustacea (*Phronima*).

Rocky pools, Lawyer Head.

Differs from *B. variegatus* chiefly in the number of fin rays.

FOURTH MEETING. *17th September,* 1872.

The Rev. Dr. Stuart, Vice-President, in the chair.

New members.—James Wilkin, W. T. Glasgow, G. E. Barton, F. R. Chapman.

1. "On a Supposed Hybrid," by A. C. Purdie.

(ABSTRACT.)

The author said that the subject of his remarks was presented to the society by Mr. Jennings as a cross between a cat and an opossum, said to be bred by Mr. Jones, of Ballarat, Australia.

It is a very well known fact that we can only get crosses or hybrids between closely allied species, and when produced they are sterile. The wide difference between the feline and the marsupial races forbids us to expect a cross or hybrid. The domestic cat crosses readily with various wild species, and it would appear that the character of the domestic breeds has at least in some cases been thus affected.

The author described the varieties and peculiarities of cats as mentioned by several writers, sufficient in his opinion to account for the appearance of this specimen, without supposing that it is a cross between the cat and opossum. He believed it to be only a cat.

2. "On Recent Additions to the Museum," by A. C. Purdie.

The author described several species of Mammalia which have been recently presented to the Museum. These included the lynx and lemming from Norway, musk-deer from Java, and some well known Australian marsupials.

3. "On the Work of the Past Year in Astronomy and Celestial Physics," by J. S. Webb. (See Appendix, p. l.)

4. M. Villaine, inventor of a special design for a submarine boat, intended to be employed in gold-mining under water, was present by invitation, and on his behalf Mr. Nuttall explained the design.

It was represented that an iron boat on this principle, 26ft. long by 7ft. in diameter, is capable of containing three men at work for six hours at the bottom, without communicating at the surface. Provision is made for propelling the boat under water. The interior of the boat is divided into compartments, namely, a ballast chamber, a place for working in, airtight compartments containing air compressed to six atmospheres, and a space into which water is admitted to sink the boat, the water being afterwards used to wash the metallic ore, there being a sluice 30ft. long in the boat. There is also an open space for allowing communication between the two ends of the vessel, and there are pipes and cocks for regulating the air, and chemical means are taken for renovating it. Provision is made for those inside to move the boat ahead or astern on the bottom, for maintaining the equilibrium of the boat, and for fixing it upon an angle of 45° or 50° if required. The mode of working it is as follows:—The boat being brought to the scene of operations, those intending to descend get into her through a man-hole. When a sufficient quantity of air has been accumulated in the reservoirs, the man-hole and air-funnels are hermetically closed, and sufficient water is then admitted to sink the boat. Once on the bottom, the compressed air is allowed to rush into the working chamber, upon which the bottom of the boat, an iron door of eight superficial feet, is opened, and work is commenced. The vessel is again brought to the surface by discharging the water taken in.

A short conversation ensued on the merits of the invention and the feasibility of working such a boat in the rapid current of the Clutha.

FIFTH MEETING. *29th October*, 1872.

The Rev. Dr. Stuart, Vice-President, in the chair.

His Honour Mr. Justice Chapman was chosen to vote in the election of the Board of Governors for the ensuing year, in accordance with clause 7 of the New Zealand Institute Act.

1. Mr. R. Gillies presented to the Society the remains of two kiwis, which had been captured on the harbour side, near Burke's brewery, by a dog of Mr. Joseph Drake's. One of the birds when found was partly devoured, but was still fresh and warm. Mr. Gillies stated that, so far as he was aware, this was the first authentic instance on record of the kiwi being found on the eastern coast of the South Island; and that, seeing the birds were running wild, the inference was that in the vast bush extending from the harbour to beyond Blueskin there must, in all likelihood, be other specimens; and, seeing that they were becoming almost extinct, it might be worth while to consider whether in the interests of science the Society should not take some steps to let the fact of the existence of these birds in that bush be as widely known as possible to the settlers, with a view to their preservation as much as possible.

In the discussion which followed, it was stated that on two or three previous occasions the capture of kiwis in the bush to the north of Dunedin had been reported, and that some specimens, one of which was now in the Museum, had been secured. It was thought that Mr. Gillies' suggestions should be acted upon.

2. "Notes on Plants collected near Invercargill," by J. S. Webb. (See *Transactions*, p. 360.)

The author gave the result of an investigation of open tussocky ground between the Puni creek and the Main East road for the purpose of comparison with that of similar ground elsewhere. He mentioned the curious circumstance that none of the imported plants, including white clover, had been able to make headway against the native vegetation, notwithstanding that cattle were constantly wandering over the ground. It was also stated that the collection included five specimens which had not before been reported as existing in the province.

Sixth Meeting. 19*th November*, 1872.

J. T. Thomson, F.R.G.S., Vice-President, in the chair.

New member.—Allan Holmes.

The Secretary announced the receipt from London of additions to the library.

The nomination for the election of honorary members of the New Zealand Institute was made in accordance with Statute IV.

1. "On the Influence of Temperature on Infant Mortality," by Dr. Deck. (See Appendix, p. xxxv.)

The Rev. Dr. Stuart suggested that the contemporaneity of the fruit season and the greatest temperature had an important share in the increase of the death-rate among children. The subject of infant mortality had been forcibly brought under his notice during the performance of his ministerial duties. Especially he had noticed that nearly all illegitimate children, subjected as they were to bad nursing and lack of care, died in infancy.

A short conversation ensued, during which Dr. Deck gave some further explanation of the subject treated upon.

2. "An Astronomical Telescope on a New Construction," by H. Skey. (See *Transactions*, p. 119.)

A model of this invention was exhibited by Mr. Skey, in which the rotatory motion was given to the vessel containing mercury by means of an electro-magnetic engine. The vibration of the floor of the room, however, rendered the action of the speculum indifferent.

3. "Notes on the Zodiacal Light," by J. S. Webb. (See Appendix, p. xlvii.)

Mr. H. Skey, in reply to some remarks in this paper on the theory he had brought before the Society on a former occasion, said that no doubt the vast extension of the Zodiacal Light in other directions than that in which he conceived it to have its greatest extension must be conceded. He had not intended to preclude this view of the shape of the zodiacal envelope.

NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY.

FIRST MEETING. *10th April*, 1872.

J. Holloway in the chair.

The receipt of new books was reported.

Resolved—That the Joint Book Committee be requested to order a fresh supply of books from London.

SECOND MEETING. *7th August*, 1872.

The Bishop of Nelson, Vice-President, in the chair.

New Members.—Joseph Giles, M.D., D. Grant, G. Bonnington, O. G. A. Harvey, W. Tomlinson.

1. "On the Mineral Resources of Nelson Province," by J. Tatton.

(ABSTRACT.)

The subject of this paper was illustrated by a number of specimens of most of the known mineral products of the province, consisting of auriferous quartz from the reefs at Collingwood and the Inangahua, also of alluvial and refined gold; ores of silver, copper, lead, zinc, chrome, iron, iron-pyrites, arsenic and antimony in their crude state, also graphite and coal, besides many of their derivative products, principally pigments manufactured from the chrome, lead, and zinc ores. Mr. Tatton also exhibited a map showing the several localities where the minerals displayed were found.

Considerable discussion took place, and a good deal of practical information was afforded to the meeting on the superiority of the pigments, chrome especially, in quality, as well as in economy in regard to cost, as compared with similar colours imported from England.

Resolved—That the Secretary be instructed to procure specimens of dried New Zealand plants to form the foundation of an herbarium for the Museum of the province.

THIRD MEETING. *28th January*, 1873.

Sir David Monro, President, in the chair.

The report and accounts of last year were read and adopted.

ELECTION OF OFFICERS FOR 1873.—*President*—Sir David Monro; *Vice-President*—The Bishop of Nelson; *Council*—Hon. J. Renwick, C. Hunter-Brown, George Williams, M.D., R. Lee, J. Shephard; *Hon. Treasurer*—J. G. Holloway; *Hon. Secretary*—T. Mackay.

The Secretary reported the receipt of new books from London, and a further supply was ordered.

The President suggested that a copy of Hooker's "New Zealand Flora" should be ordered, and at the same time remarked that when a new edition of this work was next published, it would add much to its value and usefulness if it was illustrated. It was considered, therefore, that a suggestion to this effect should be conveyed to the Board of the New Zealand Institute in order that they may communicate with Dr. Hooker on the subject.

A conversation arose on the question of the utilization of the Botanical Gardens in Nelson. It was generally considered that, if the provincial funds would allow of it, these gardens might be turned to good account in trying experiments of "Economic Botany;" for instance, in the proper cultivation of sugar-beet, sugar-grass (*Sorghum saccharatum*), and other plants, as well as trees, whose products might be suitable for local industries.

1. "On the cultivation of Sugar-beet in New Zealand," by T. Mackay, C.E.

(ABSTRACT.)

As the cultivation of sugar-beet, and its manufacture into sugar, has been occupying of late a considerable amount of attention in New Zealand, the following information, gained principally from some practical acquaintance with the subject, may not be uninteresting at the present time :—

There are in cultivation four kinds of beet, viz. :

1. The long red, or garden-beet, so much used as a salad.

2. The white Silesian, or sugar-beet, with its sub-variety, the rose-coloured.

3. The sea-beet, the leaves of which are well known as an excellent substitute for spinach.

4. The mangold-wurzel, or field-beet. Von Thäer, a German writer on agriculture, is of opinion that the field-beet is a hybrid betwixt the red garden-beet and the white sugar-beet. Others say that it is the original stock, and that the finer varieties have been produced from it by higher cultivation—a more likely conjecture.

Of the white sugar-beet (*Beta alba*) there are more than one species. It has a pear-shaped root and light green top, green leaves with lighter-coloured

ribs and white flesh. There is a variety of it which has a rose-coloured skin, leaves marked by purple-coloured ribs, but the flesh is white like that of the former. There is no difference in their sugar-yielding qualities.

The average temperature of the continental beet-growing countries, and of the localities in England where beets are grown to advantage, ranges from 62° to 65° Fahr.

The average composition of the root of the sugar-beet of France, Belgium, and the Rhenish provinces, is theoretically nearly as follows :—

Sugar	$10\frac{1}{2}$	per cent.
Gluten	3	„
Fibre	5	„
Water	$81\frac{1}{2}$	„
	100	

Practically the per centage of sugar extracted reaches about 8 per cent. But the proportion varies very much. Thus it is greater :—

1. In small beets than in large. Chemical inquiry has proved that the proportion of sugar was larger, and of salt less, in beets not weighing more than three pounds. One per cent. of salt in the sap will render three per cent. of the sugar uncrystallizable. The best roots weigh on an average from one and a half to two and a half pounds each.

2. In dry climates, and especially when the climate is dry after the roots have begun to swell.

3. When grown in light potato or barley soils than in heavy soils. The land should be well drained and capable of being cultivated to a depth of eighteen inches.

4. In the part under than above ground. The tap root is the richest in sugar.

5. When manure has not been directly applied to the crop, as its contact with the plants occasions unequal growth, as well as infests them with various kinds of insects. Strictly speaking the manure should be worked into the ground some months previously to the seed being sown. Superphosphate of lime and bone-dust are the best manures for this root.

It has been proved that a crop raised by means of the direct application of manure contains more salt, and gives more uncrystallizable syrup, than when raised without direct manuring. At the factory where this was tested a larger price, therefore, was offered for roots grown upon land which had been manured during the previous winter; a higher still for such as were raised after a manured crop of corn; and a still higher when after the manuring two crops of corn were taken before the beet was sown.

In France and Belgium the crops gathered are from fourteen to fifteen

tons an acre, while about Magdeburg, in Prussian Saxony, they do not exceed ten or twelve tons. But the latter are richer in sugar and poorer in salts in proportion.

These facts show how much practical agriculture, as well as climate, have to do with the success of this important manufacture.

Having regard, therefore, to the use and application of suitable manures, and the proper rotation of crops, the mechanical cultivation of the sugar-beet should be pursued as follows :—

The ground is to be prepared for it in the same manner as for mangold-wurzel, turnips, or carrots. The best seed is to be got from Magdeburg, in Prussia, or from M. Vilmorin, the celebrated seedsman in Paris. It should be sown in this country in October. Ten pounds to twelve pounds of seed is the quantity required per English acre. Sugar-beets are planted more closely than mangolds. The distance between the rows, and from plant to plant, should not be less than twelve inches nor greater than eighteen inches. If the young plants are caught in spring by a night's frost they should be ploughed up and fresh seed sown. They should be horse and hand-hoed. The earth should be well gathered up round each plant, in order that the head of each root may be completely covered with soil. When the roots begin to show the commencement of decay in the leaves, they are ripe, and should be dug out, the mould gently shaken off, and the heads cut off together with as much of the roots as shows the presence of leaf-buds. They should then be piled in heaps on the ground to hinder the evaporation of their moisture, and covered with a layer of earth to protect them from light and frost. A beet-root of good quality should not exceed three pounds in weight, and should be firm, brittle, emitting a creaking noise not unlike a pine-apple when cut, and perfectly sound within; the degree of sweetness is also a good indication.

It will be seen by these directions what conditions are necessary to ensure a good root for sugar purposes. Until, however, the experiment which is now being tried of cultivating it in the neighbourhood of Nelson has been tested by chemical analysis, it would be premature to enter into the details of its further treatment in reference to its manufacture into sugar; if the result is satisfactory, there will be read to you at a future time a continuation of this paper, dealing with the several aspects of the question in a manufacturing point of view.

An interesting discussion ensued on the nature of the different kinds of sugar-beet, as well as on their cultivation and manufacture into sugar at a profit in New Zealand, and a vote of thanks was accorded to Mr. Mackay, for his useful and practical paper.

APPENDIX.

THE CLIMATE OF NEW ZEALAND.

METEOROLOGICAL STATISTICS.

THE following Tables, etc., are published in anticipation of the Report of the Inspector of Meteorological Stations for 1872.

TABLE I.—TEMPERATURE of the AIR, in shade, recorded at the Chief Towns in the NORTH and SOUTH ISLANDS of NEW ZEALAND, for the year 1872.

Place.	Mean Annual Temp.	Mean Temp. for (SPRING) Sept., Oct., Nov.	Mean Temp. for (SUMMER) Dec., Jan., Feb.	Mean Temp. for (AUTUMN) Mar., Apl., May.	Mean Temp. for (WINTER) June, July, Aug.	Mean daily range of Temp. for year	Extreme range of Temp. for year.
NORTH ISLAND.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.
Mongonui*	62·1	60·5	†72·0	64·3	55·0	14·9	56·0
Auckland	60·2	57·3	69·5	61·8	52·4	13·9	56·4
Taranaki	58·4	56·3	65·7	60·3	51·1	17·0	52·0
Napier	59·7	57·8	69·2	60·3	51·5	17·0	64·0
Wanganui	56·7	54·5	65·1	58·6	48·8	16·6	58·0
Wellington	55·8	54·1	63·7	57·4	48·1	11·6	51·5
Means, etc., for North Island	58·8	56·7	67·5	60·4	51·1	15·2	64·0
SOUTH ISLAND.							
Nelson	56·7	55·5	66·6	57·9	47·0	20·9	65·0
Christchurch ...	53·6	53·2	64·4	53·8	43·2	15·0	74·2
Hokitika	54·1	53·4	61·1	56·6	45·2	12·0	55·0
Dunedin	51·4	51·9	59·5	52·0	42·3	14·7	61·0
Queenstown... ...	51·4	51·7	61·7	53·1	39·2	16·7	61·7
Southland*	49·2	51·2	†57·6	52·2	40·1	18·7	68·0
Means, etc., for South Island	52·7	52·8	61·8	54·2	42·8	16·3	74·2
Means for Nth. and Sth. Islands	55·7	54·7	64·6	57·3	46·9	15·7	74·2

* For eleven months; no returns for December furnished.

† For January and February only.

TABLE II.—BAROMETRICAL OBSERVATIONS.—RAINFALL, etc., recorded for the year 1872.

Place.	Mean Barometer reading for year.	Range of Barometer for year.	Mean Elastic Force of Vapour for year.	Mean Degree of Moisture for year.	Total Rainfall.	Mean Amount of Cloud.
NORTH ISLAND.	Inches.	Inches.	Inches.	Sat.=100.	Inches.	0 to 10.
Mongonui* ...	30·024	1·407	...	...	45·330	5·3
Auckland ...	30·024	1·404	·428	80	42·096	6·3
Taranaki ..	30·001	1·429	·305	62	63·640	6·7
Napier	29·980	1·420	·389	74	23·940	2·0
Wanganui ...	30·087	1·520	·332	71	38·120	4·8
Wellington ...	29·934	1·629	·351	79	50·945	5·6
Means for Nth. Island	30·008	1·468	·361	73	44·012	5·1
SOUTH ISLAND.						
Nelson	29·919	1·518	·369	79	78·610	6·1
Christchurch ...	29·915	1·702	·333	79	19·741	5·6
Hokitika ...	29·944	1·543	·361	85	123·210	4·8
Dunedin ...	29·819	1·351	·293	76	27·393	5·8
Queenstown ...	...	...	·257	67	28·880	5·3
Southland* ..	29·840	1·631	·275	77	40·110	5·7
Means for Sth. Island	29·887	1·549	·314	77	52·990	5·5
Means for Nth. & Sth. Islands	29·947	1·508	·337	75	48·501	5·3

* For eleven months; returns for December not furnished.

TABLE III.—WIND for 1872,—Force and Direction.

Place.	Average Daily Velocity in miles.	Number of days it blew from each point.								
		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
NORTH ISLAND.										
Mongonui* .	169	20	39	51	40	12	56	22	82	13†
Auckland ...	291	43	84	40	16	50	75	29	20	9
Taranaki ...	...	39	85	30	65	1	87	27	32	0
Napier ...	234	24	141	10	24	32	51	38	34	12
Wanganui ...	256	33	24	6	25	0	80	35	117	46
Wellington	204	21	27	8	111	5	6	7	179	2
SOUTH ISLAND.										
Nelson ...	...	35	84	12	52	7	67	39	70	0
Christchurch	...	10	90	78	21	15	105	7	30	10
Bealey ..	...	0	26	1	33	0	22	0	208	76
Hokitika ..	146	58	64	61	66	5	48	18	39	7
Dunedin ...	168	35	29	30	36	28	43	52	15	98
Queenstown	139	2	14	0	11	1	57	14	125	142
Southland*	191	95	31	28	25	27	26	57	46	0

* For eleven months; returns for December not furnished.

† These returns refer to the particular time of observation, and not to the whole twenty-four hours, and only show that no direction was recorded for the wind on that number of days.

TABLE IV.—Bealey,—Interior of Canterbury, at 2,104 feet above the sea.

Mean Annual Temp.	Mean daily range of Temp. for year.	Extreme range of Temp. for year.	Mean Barometer reading for year.	Range of Barometer for year.	Mean Elastic Force of Vapour for year.	Mean Degree of Moisture for year.	Total Rainfall.	Mean Amount of Cloud.
Degrees.	Degrees.	Degrees.	Inches.	Inches.	Inches.	Sat.=100.	Inches.	0 to 10.
48·0	15·9	70·0	29·798*	1·433	·291	85	97·130	5·4

* Reduced to sea level.

TABLE V.—Earthquakes reported in New Zealand during 1872.

Place.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Tauranga ...	15*	..	...	...	...	...	...	...	..	...	...	...	1
Maketu ...	15*	...	...	...	...	..	..	...	...	...	...	...	1
Taupo ...	...	...	...	...	...	5*6*	...	...	...	...	...	...	2
Taranaki ..	...	..	...	...	...	...	...	...	...	...	...	26	1
Tarawera ...	...	...	...	...	...	7†18†	...	...	..	...	...	...	2
Patea ...	..	...	...	...	...	...	...	...	5, 20*	...	..	...	2
Hawera ...	...	...	...	...	...	...	...	...	20*	..	...	...	1
Napier ...	...	...	14	...	...	18*	...	...	...	...	...	...	2
Waipukurau	...	..	...	...	...	...	...	2*	...	...	...	...	1
Wanganui ...	...	14	...	..	...	...	2*	...	10, 20*	10	...	...	5
Foxton ...	...	...	...	...	...	...	2†	2	5,20	4	...	...	5
Bull's ...	...	...	..	...	..	...	2*	...	20*	...	...	...	2
Greytown ..	...	..	...	...	...	...	2	...	...	...	...	1	2
Hutt ...	..	...	...	...	...	...	...	...	20*	...	..	...	1
Wellington ...	...	..	3	10	...	...	2	4	20*24	14	1	13	9
Blenheim ...	...	...	...	...	..	...	...	...	...	..	...	26*	1
White Bay	...	..	..	...	...	...	...	...	20*	...	...	...	1
Nelson ...	...	...	...	...	...	11	..	...	20*	14*	...	26*	4
Farewell Spit	...	10	...	...	...	...	...	...	...	...	...	...	1
Cheviot ..	...	15	...	...	...	...	...	...	...	...	...	...	1
Timaru ...	26	..	...	...	...	...	...	...	...	...	...	...	1
Queenstown	...	9*	6	...	...	...	29	...	6	...	...	...	4
Dunedin ..	..	...	...	...	...	...	...	...	...	...	20*	...	1
Tairoa Head	...	...	...	...	...	...	...	...	...	...	20*	..	1
Bluff ...	...	...	...	...	...	..	..	...	...	..	..	16	1

The figures denote the days of the month on which one or more shocks were felt. Those with an asterisk affixed were described as *smart*; those with a dagger as *severe shocks*. The remainder were very slight, and may have escaped record at some stations, there being no instrumental means employed for their detection.

Note.—On 15th October strong magnetic currents reported at Napier, Wellington, White Bay, Christchurch, and Blenheim, affecting telegraph wires and stopping work; also on 18th similar occurrence on wires at Nelson, Dunedin, and White Bay.

TABLE VI.—COMPARATIVE ABSTRACT for 1872, and previous Years.

STATIONS.	Barometer.		Temperature from Self-registering Instruments read in Morning for Twenty-four hours previously.					Computed from Observations.		Rain.		Wind.		Cloud.
	Mean Reading.	Extreme Range.	Mean Temp. in Shade.	Mean Daily Range of Temp.	Extreme Range of Temp.	Max. Temp. in Sun's Rays.	Min. Temp. on Grass.	Mean Elastic Force of Vapour.	Mean Deg. of Moisture. (Saturation=100)	Total Fall in Inches.	No. of Days on which Rain fell.	Average daily force in Miles for Year.	Maximum Velocity in Miles in any 24 hours, and date.	Mean Amount (0 to 10).
NORTH ISLAND.														
Mongonui*	30·024	1·407	62·1	14·9	56·0	150·0	—	—	—	45·330	170	169	580, Feb. 21	5·3
Previous years	29 928	—	57·9	—	—	—	—	—	—	54·520	152	—	—	—
Auckland	30·024	1·404	60·2	13·9	56·4	157·0	13·0	·428	80	42·096	186	291	876, Sept. 8	6·3
Previous years	29 843	—	60·1	—	—	—	—	·413	72	44·333	183	—	—	—
Taranaki	30·001	1·429	58·4	17·0	52·0	153·0	22·0	·305	62	63·640	158	§—	—	6·7
Previous years	29·909	—	57·5	—	—	—	—	·405	76	53·484	157	—	—	—
Napier	29·980	1·420	59·7	17·0	64·0	147·0	—	·389	74	23·940	108	‡234	700, Mr. 3, May 15, Oct. 7 & 8	2·0
Previous years	29·876	—	57·2	—	—	—	—	·331	72	36 297	74	—		—
Wanganui	30 087	1·520	56·7	16·6	58·0	148·0	10·0	·333	71	38·120	135	256	692, Mar. 2	4·8
Wellington	29·934	1·629	55·8	11·6	51·5	145·0	21·0	·351	79	50·945	165	204	800, Apl. 20	5·6
Previous years	29·872	—	55·6	—	—	—	—	·312	68	46·728	143	—	—	—
SOUTH ISLAND.														
Nelson	29·919	1·518	56·7	20·9	65·0	185·0	15·0	·369	79	78·610	102	§—	—	6·1
Previous years	29·932	—	55·3	—	—	—	—	·385	74	62·634	84	—	—	—
Christchurch	29·915	1·702	53·6	15·0	74·2	160·2	5·2	·333	79	19·741	114	§—	—	5·6
Previous years	29 843	—	52·8	—	—	—	—	·323	76	25·160	107	—	—	—
Bealey†	29·798	1·433	48·0	15 9	70·0	142·6	−16·0	·291	85	97·130	170	§—	—	5·4
Previous years	29·852	—	46·1	—	—	—	—	·262	82	126·018	214	—	—	—
Hokitika	29·944	1·543	54·1	12·0	55·0	103·0	17·5	·361	85	123·210	179	146	403, July 16	4·8
Previous years	29 925	—	51·7	—	—	—	—	·376	90	119·403	206	—	—	—
Dunedin	29·819	1·351	51·4	14·7	61·0	184·0	20·0	·293	76	27·393	132	168	500, July 7, & Sept. 25	5·8
Previous years	29 902	—	50 8	—	—	—	—	·274	71	34·506	181	—		—
Queenstown	—	—	51 4	16·7	61·7	156·2	—	·257	67	28·880	117	139	273, April 20	5·3
Southland*	29·840	1·631	49·6	18·7	68·0	162·2	14·0	·275	77	40·110	144	191	621, Nov. 30	5·7
Previous years	29·768	—	49 8	—	—	—	—	·262	73	49 686	163	—	—	—

* For 11 months; no returns for December received. † 2,104 feet above sea level. ‡ For 10 months only.

§ Instruments out of order; observations incomplete.

Notes on the Weather during 1872.

January.—The drought in all the eastern parts of the colony, which commenced in the North in November, and in other parts in December, continued throughout this month, accompanied by very still weather, and atmospheric pressure above the average. The heat has been very seriously felt, the temperature registered both in the shade and sun being greatly in excess of any previous records.

February.—Rainfall and temperature in excess; winds generally moderate, but a strong S.E. to N.E. gale was felt at all stations from Nelson northward. Destructive floods at Greymouth on 8th.

March.—Weather on the whole remarkably fine throughout the Colony. Rainfall considerably below the average, and no storms of any note. Very high barometer readings were recorded at nearly all the stations on 21st and 22nd. Auroras in extreme south on 2nd.

April.—This month was remarkable for the unusual amount of rain that fell throughout the colony. There were no very severe gales except at Wellington, where on the 18th and 19th a heavy S.W. storm with excessive rainfall occurred, doing much damage. The atmospheric pressure was low throughout, and temperature higher than usual.

May.—Wet and stormy generally during this month, with prevailing westerly winds. Severe thunder-storm on 1st in North with rain; thunder also in the South towards end of month; the temperature higher than usual; snow and hail in South. At times weather pleasant.

June.—Very cold, severe weather throughout, with much snow, hail, and rain; unusually severe frosts and snow-storms in the South. In Southland snow continued from 10th for five days, fifteen inches deep, wind W., and low barometer.

July.—Stormy, wet, and severe weather generally throughout, with frequent thunder, hail, and snow, and heavy falls of rain. At Nelson and Hokitika, rain considerably above the average.

August.—Temperature below the average throughout, generally fine in North, and rain moderate; in the South very severe cold weather, especially in early part of month, when a heavy snow-storm occurred, also heavy rain and frequent thunder-storms. Aurora observed in North on 9th.

September.—Very fine weather throughout for time of year; no severe storms recorded, and unusually small rainfall; very high atmospheric pressure

occurred about the middle of month with fine clear weather. Meteor reported at Christchurch on 14th.

October. — Weather generally fine and seasonable; rainfall about the average. Frequent auroras observed in the South. Meteor seen at Auckland on 3rd, very brilliant.

November.—Exceedingly dry hot weather throughout the colony, and in many places the drought was severely felt. No gales of any note occurred. At times there were cool, pleasant breezes. Very high atmospheric pressure at nearly all the stations on 20th, which continued for a few days and gradually fell; very fine weather at this period. Aurora in South on 24th; meteor seen at Wellington and Nelson on 28th, and at Queenstown on 22nd.

December.—Temperature about 5° above the usual average, accompanied by excessive drought at all stations except Hokitika and Bealey, where rain was in excess. Atmospheric pressure above the average, and especially high from 6th to 8th all over the colony. Maximum temperature in shade 92·3° at Christchurch, on the 25th. The range of temperature between night and day unusually great.

JAMES HECTOR,
Inspector of Meteorological Stations.

Lecture on the Formation of Mountains. By Captain HUTTON, F.G.S., C.M.Z.S.

[*Substance of a lecture delivered in the Colonial Museum, Wellington, 13th November,* 1872.]

"We must never forget that it is principles, and not phenomena—the interpretation, not the mere knowledge of facts—which are the objects of inquiry to the natural philosopher."—SIR J. HERSCHEL.

THE formation of mountains does not very well describe the subject on which I propose to lecture to night, for, strictly speaking, mountains are formed by rain and snow sculpturing and grooving what would otherwise have been table lands, or the highest portions of the undulations of the earth's surface; but on this subject I do not mean to touch. I propose to deal with the undulations themselves, out of which mountains are carved by the rain.

It is well known that the solid surface of the globe is uneven and undulating, that the lower portions are covered by the ocean, while the higher are called the land, and it has also been proved, by observations extending over nearly a century, that these undulations have changed in form and position over and over again, and that changes are still going on. That the solid surface of the earth should heave and quiver, and sway up and down, is one of the most extraordinary phenomena of nature with which science has made us acquainted, and it is one which has never yet received a satisfactory explanation. I hope, however, to be able to show you that it is but the necessary effect of causes which we know from observation to be constantly going on on the surface, combined with the conduction outwards of the interior heat of the earth.

In order to make what I have to say quite clear to you, I must first briefly refer to some general considerations on the interior of the earth. Fortunately, it will not be necessary for me to enter into the hotly disputed question as to whether it is fluid or solid, for this is immaterial to the views that I have to advance; all that is necessary being that the interior is very hot. This is allowed, I believe, by all scientific men, the proof resting principally on the facts that we know from observations, wherever they have been made, that the temperature actually does rise as we descend, at an average rate of about 1° Fahr. for every fifty feet, and that the density of the earth is so small, not much more than twice that of the ordinary rocks of the surface, that there must be some expansive force in the interior sufficiently powerful to balance in a great measure the enormous pressure to which the interior of the earth would be subjected. Assuming then that the interior of the earth is intensely heated, and that the temperature, for a depth say of fifty miles from the surface, increases at the rate of 1° Fahr. for each fifty feet, it necessarily follows that the outer shell, or "crust" as it is commonly called, to

a depth of somewhere about thirty-five miles has a temperature below the melting point of ordinary rocks at the surface, while all below this depth has a temperature above its melting point at the surface. Consequently, we have an outer crust in which the attraction of cohesion among the molecules is greater than the repulsion caused by heat, surrounding a nucleus in which the repulsion caused by heat among the molecules is greater than the attraction of cohesion.

The outer crust must therefore be more or less rigid, while the superheated interior must be in such a state that if the pressure that keeps it in its place is decreased at one point it will expand, and this expansion will permeate through the whole mass until the pressure is again equally distributed throughout. Conversely, if the pressure is increased on any point, this pressure will affect the whole mass and distribute itself evenly through it. Of course I need hardly say that the rigid state of the crust is not separated from the superheated state of the interior by a marked division, but the one passes imperceptibly into the other. Now each portion of this rigid crust must be maintained in its place by three forces, viz.—its weight, the lateral thrust of the arch, and the outward pressure of the superheated interior. While these three forces remain constant equilibrium will be maintained, and no movements will occur on the surface. But if one or more of these forces change in amount, the equilibrium will be subverted and movements of the surface will take place. If also the equilibrium be disturbed at one place, it follows, from what I have said about the distribution of pressure in the superheated interior, that the equilibrium will also be disturbed in all surrounding areas. If, for instance, an upheaval of the crust should take place at any point, the underlying superheated rocks, being thus relieved from the pressure above them, would expand and rise up, and fill the hollow; but this expansion would spread through the mass, and would therefore lessen the outward pressure of the interior in all the surrounding areas, which would consequently subside, and equilibrium would only be once more restored when the mass of the subsided areas equalled the mass of the elevated area. Consequently elevation implies subsidence, and *vice versâ*. Where now must we look for the causes that are in operation to disturb this equilibrium? The most obvious is the radiation of heat into space by the earth, and the consequent cooling and contraction of the superheated interior. This is at present almost universally accepted by geologists as the cause of the movements of the surface and the upheaval of mountain chains, but many arguments have been urged against it, and although I am willing to allow that it must have some effect in producing movements, these effects are, I think, completely absorbed by the much larger ones that flow from causes that I shall presently describe; and it is quite impossible that it can be the only cause of movement, partly because

some effect must be produced by the other causes that I have yet to describe, and partly because since the glacial epoch the earth has been warming instead of cooling, and consequently no contraction can have taken place since then, while we know not only that extensive movements have taken place, but that they are still taking place on the surface of the globe.

The other cause of disturbance of the equilibrium, to which I have alluded, is the removal of matter from one portion of the earth by running water and its deposition on another portion. It is now nearly forty years ago since Mr. C. Babbage, in his celebrated paper, read before the Geological Society of London,* on the temple of Jupiter Serapis, proposed a theory to account for oscillations of the surface of the earth, which he called the theory of "the change of isothermal surfaces." At about the same time, Sir J. Herschel, in a letter to Sir C. Lyell,† proposed to account for the same phenomena by a theory which he called "the alteration of the incidence of pressure." Both these theories are founded on the same fact, viz., the removal of matter from one portion of the earth's surface and its deposition on another; but while Mr. Babbage laid the most stress on the changes of internal temperature that would be thus brought about, Sir J. Herschel laid the most stress on the change of direct pressure, or weight. These theories have never been taken up by geologists, but I hope to be able to show to you that, when combined, they are capable of explaining all, or nearly all, of the observed phenomena. I have already told you that, owing to its internal heat, the mean temperature of the earth increases as we descend into it at the rate of about 1° Fahr. for every fifty feet. If, therefore, the mean temperature of the surface at any place was 50° Fahr. the mean temperature 100 feet below would be 52° Fahr. If now the surface was covered up by a deposit of clay or sand 100 feet thick, and if its surface retained the same mean temperature as the old one, viz., 50° Fahr., the mean temperature of the old surface would be raised 2°, or to 52°, while at 100 feet below it would be 54°, and so on, so that the covering of the surface by a deposit 100 feet thick would raise the temperature of the whole underlying rocks 2°. If the deposit was thicker, the temperature would of course be more raised in proportion. Now we know that rocks expand on being heated‡ and contract on being cooled, and Colonel Totten and Mr. Adie have shown that this expansion for each degree of temperature is from $\frac{1}{25,000}$ to $\frac{1}{10,000}$ of the whole, according to the nature of the rock. If, however, the deposit was unconsolidated, like clay or sand, and the particles were free to move among themselves, this expansion would have very little effect in raising the surface; but if the deposit was rigid, like limestone, the effect would be totally different, and the irresistable pressure, caused by the expansion of the

* Q. J. G. S., III., 186. † Pro. G. S., II., 548., 596.

‡ Clay contracts on being heated, but this does not affect the theory.

rock, could only be relieved by the whole stratum bulging upwards and forming an arch, or more properly a dome; and as we know the rate of expansion, we can calculate what the elevation would have to be on a sphere the size of the earth, for various temperatures and for different areas, in order to relieve the pressure. This is exhibited in the following table, which is part of a larger table that I have calculated.* In it the upper line is the thickness in feet of the deposit, while the second line is the temperature due to that thickness. The left-hand column is the diameter, or breadth, in miles of the heated area, while the other columns show the elevation in feet that would take place :—

Thickness	500 feet	2,500 feet	10,000 feet	25,000 feet
Temperature	10°	50°	200°	500°
Breadth, 100 miles ...	1,140 feet	3,700 feet	8,700 feet	14,600 feet
„ 500 „ ...	1,550 „	7,220 „	24,200 „	49,300 „
„ 1,000 „ ...	1,570 „	7,700 „	28,600 „	65,400 „
„ 2,000 „ ...	1,900 „	7,800 „	30,700 „	74,400 „

From this table it will be seen that formations no thicker nor more extensive than those that we know to have been deposited, are quite capable of being elevated far above the highest known mountains.

It may have occurred to you that a bed of limestone would not be capable of supporting itself as an arch, and, therefore, that instead of being elevated it would break up into fragments; this is very true, if the arch was entirely unsupported, but as soon as the expansion overcame the rigidity of the crust, and movement commenced, the underlying superheated rocks, being relieved from pressure, would rise up and still press upwards on the rising arch, so that the pressure expended in elevation would be that capable of overcoming the rigidity only of the crust, and not its weight. You may also have noticed that unless the rate of deposition was greater than the rate of the conduction of heat outwards, no deposit would rise above the surface of the sea, for as soon as deposition ceased the increase of temperature would cease also; and conversely, the greater the difference between the rates the greater would be the rise, for the longer would be the time before the deposit attained its normal temperature.

The data to estimate these rates are not very exact, more especially the rate of deposition, but the following is the best information that I can collect :—

Monsieur Joseph Fourier has calculated that the earth decreases in tem-

* This table is calculated on the suppositions that the earth is a sphere, with a radius of 3,956 miles, and that rocks expand ·000005 for 1° Fahr.

perature by radiation 1° Fahr. in 3,000,000 years,* and from this we can deduce that the conduction outwards must be about one-tenth of an inch a year. Sir W. Thomson's calculations, founded on experiments made at Edinburgh, Greenwich, and Upsala, give an outward conduction two and three-quarter times as fast; but these experiments were made on dry rocks, and he allows that if the rocks were saturated with water, as all newly-formed deposits would be, his estimate would have to be reduced by one-half; which would then give an outward conduction of one-eighth of an inch per year. Peclet's experiments show also that the conductivity of limestone is only two-fifths of the average taken by Sir W. Thomson, or one-tenth of an inch per year. Consequently, we cannot be far wrong if we take the average conductivity outwards at one-ninth of an inch per year.

Professor Dana has estimated that limestone grows at the rate of one-eighth of an inch per year, and sandstone five to ten times as fast, or from five-eighths to one and a quarter inch per year; while the average increase in thickness of the clays of deltas appears to be about one-fifth of an inch per year; so that if we suppose a formation to be about one-third limestone, we get an average rate of deposition for the whole formation of one-third of an inch per year, or three times as fast as the conduction of heat outwards.

If at the present time the internal heat travels outwards at the rate of one-ninth of an inch per year, it would take 54,000 years to heat a deposit 500 feet in thickness; but a deposit 500 feet in thickness implies a rise of temperature in the underlying rocks of 10°, which implies an elevation of 1,140 feet if the heated area was 100 miles in diameter, or 1,900 feet if it was 2,000 miles in diameter, consequently in the first case the land would have risen 1,140 feet, and in the last 1.900 feet in 54,000 years, or at the rate of from two to three and a half feet per century, which is just the rate that Sir C. Lyell considers as most probable from observation.

But in former times when the internal temperature increased three times as fast as it does now, or 1° for seventeen feet, the conduction outward would be equal to the deposition, and consequently no land could rise above the water, and this may have been the cause of the "insular condition" which seems to have prevailed over the world during palæozoic times. According to the theory of the secular cooling of the earth advocated by Sir W. Thomson, these conditions must have occurred about eleven and a half millions of years after the formation of the crust, or about eighty-eight and a half millions of years ago. From that time to the present, elevation must have gone on in an increasing scale; but, although increasing in height, it must have also been decreasing in rapidity, and a time must inevitably arrive when elevation will be so slow that it will do no more than equal denudation, and when again,

* Theorie de la Chaleur, Paris, 1822.

therefore, no more land can rise much above the surface of the sea. Now, it has been estimated that a foot of soil is removed by denudation in from 500 to 12,000 years, according as the land is mountainous or level, and if we take the lowest estimate as that which will be nearest to the conditions at the time I am talking about, we find that the interior heat would have to increase at the rate only of 1° in 10,000 feet to bring about the result.* This, by Sir W. Thomson's theory, will not be for thirteen billions of years; so that the earth is but in its infancy between birth and the repose of old age, and we have plenty of time to look forward to for improvement and development.

But leaving these speculations, it is, I think, time that I gave you an illustration of the theory. I select the Wealden District in the South of England. This district extending through Kent, Sussex, and Hampshire, is formed by an anticlinal curve of the cretaceous and wealden strata. The thickness of the beds is 3,400 feet, and the highest part of the arch would have attained, if the upper portion had not been denuded off, a height of about 3,600 feet above the sea. The base of the arch below London is about 500 feet below the sea, so that the total rise of the arch must have been about 4,100 feet, while the breadth of the anticlinal from London to some point in the English Channel is about 100 miles; these, therefore, are our data. Now a thickness of 3,400 feet implies an elevation of temperature of 68°, and this over a breadth of 100 miles would give an elevation of 4,650 feet, that is to say 150 feet more than the actual rise. But as the land rose above the sea denudation would commence to work upon it, so that the temperature would not be able to rise the whole 68°, and this will account for the 150 feet which the anticlinal arch failed to attain.

I will give you another and more general illustration. During the Eocene period a large ocean, at least 5,000 miles long by 1,800 broad, extended over the south of Europe and the north of Africa, and was continued eastward through Asia Minor, Persia, and Northern India to China. In this ocean, what is known as the mummulitic limestone was formed to a thickness of 15,000 feet. Consequently if, as I have said, large limestone deposits produce elevation, it is here that we ought to find the evidence of it; and this we plainly do in the Atlas, Pyrenees, Alps, Apennines, Carpathians, Himalaya, and the mountain chains of Persia; we find, in fact, that the area of the mummulitic limestone embraces the most mountainous country in the world, and geology shows us that these mountains are all about the same age, and all have been elevated since the period of the mummulitic formation. A thickness of 15,000 feet of limestone over an area 1,800 miles in breadth is

* I need hardly say that these numbers are introduced as an illustration merely, and make no pretension to accuracy.

also more than sufficient to elevate into the air the most towering peaks of the Himalaya.

I might also adduce the Appalachian mountains in America as a beautiful illustration of the theory, every elevation that has taken place distinctly following the deposition of limestone, and occurring only where the limestone was deposited, except, perhaps, the last elevation after the carboniferous period, which at present I cannot account for—for, according to American geologists, the carboniferous limestone never overlaid these mountains. But, besides the deposition of matter, any other cause that changed the temperature of the surface, would also produce alterations of level—a rise in the temperature being followed by elevation, and a fall by subsidence owing to the cooling and contracting rocks forming part of the surface of a sphere. In this way, the Gulf Stream, by raising the temperature of Norway and Sweden, is causing them to rise; while the cold Arctic current, sweeping down through Baffins' Bay and striking against Greenland, is causing that country to sink.

Turning now to the second cause of the subversion of equilibrium, viz., change in the incidence of pressure, we find our data not so satisfactory, for we have no means of estimating the rigidity of the crust, and therefore of the weight it would bear before beginning to move, but nearly all geologists agree that most thick formations of sandstones and clays have been deposited upon a sinking area, and that in a large number of cases the subsidence has been approximately equal in rapidity to deposition. Now the chances are, of course, enormously against subsidence being equal to deposition, unless one is caused by the other, and when many cases of the kind are brought forward, our former suspicion becomes almost a certainty. This, of course, only applies to clays and sandstones, for I have already shown that limestones, as soon as they begin to expand by heat, rise up and relieve the pressure; but with unconsolidated beds, like clay or sand, the horizontal thrust could never get powerful enough to overcome the rigidity of the crust, and consequently they could never rise.

As large deposits of limestone, therefore, elevate areas, so large deposits of argillaceous strata depress them. But while argillaceous strata are being formed they will not only be compressed by the sinking of the spherical surface on which they rest, but they will also at the same time be expanded by heat, and these two, together, will throw the beds into folds or contortions.

If we suppose that the subsidence is equal to the thickness of the formation, which is the most reasonable supposition that we can make, we can calculate the amount of compression due to sinking, and to expansion from heat, due to different thicknesses. Some of these are given in the following table, the

upper line of which represents the thickness of the formation in feet, and the lower the proportionate compression :—

Thickness	5,000 feet	10,000 feet	20,000 feet	25,000 feet
Compression	$\frac{1}{1000}$	$\frac{1}{500}$	$\frac{1}{300}$	$\frac{1}{200}$

A first inspection of this table will give the impression that these compressions are not nearly enough to account for the contortions we see in mountain districts, but I believe that our ideas of contortions are very incorrect, owing to the necessarily exaggerated sections that accompany geological descriptions. The only sufficiently accurate section that I have been able to see is Professor Ramsay's beautiful section through Snowdon, in North Wales, and after carefully measuring it, and allowing for the faults and intrusive rocks, I find that the compression in this mountainous district is one sixteenth. We must also remember that the contortions that we now see are the sum of all the compressions that have taken place at various times, for the rocks after being bent do not straighten out again on being stretched, but elongate by faulting. A considerable amount of the contortions of the lower beds of a formation will also be a necessary consequence of elevation by expansion, for during elevation the lower beds will not be able to expand so much as the upper ones of the arch, although much more heated.

The subsidence of an area caused by the weight of newly-deposited matter will compress the underlying superheated rocks, and, as explained at the commencement of the lecture, this will cause an increase of upward pressure in the surrounding areas. This increase of upward pressure will cause elevation in the surrounding districts, the rocks will be subjected to tension, and fissures will be formed. Up these fissures the superheated rocks of the interior will rise, and if they reach the surface will form volcanoes and overflow as lava streams. In this way mountains of quite a different character to those we have lately considered will be formed.

I have now explained to you the theory of Messrs. Herschel and Babbage in its simplest form, but in nature we should rarely find this simplicity. These two great powers—expansion by heat, and increase of weight—would sometimes combine and sometimes interfere with each other. Complications would also arise from the different degrees of fusibility, conductivity, porosity, and expansion of rocks, while the changes in physical geography caused by the changes in the position of the land would constantly alter the mean temperature of the surface, so that very complex phenomena might result from these simple causes.

To sum up. Mountain chains are of two kinds. The first, of which the Alps may be taken as a type, are composed of folded and contorted strata,

generally associated with metamorphic and granitic rocks. These have been formed by heavy argillaceous deposits, causing subsidence and contortion, which have been subsequently elevated by the superposition of calcareous beds. The second kind, of which the Andes may be taken as the type, are composed of nearly horizontal strata, generally associated with volcanic rocks.* These have been formed by the upward pressure of the underlying rocks caused by the subsidence of adjoining areas, and owe their height partly to this upward pressure, but often in great part to the overflowing of the superheated rocks on the surface.

There is, however, one other point that has still to be taken into account. If we calculate the mass of the ocean we shall find that it is sufficient, if the surface of the earth were level, to cover it entirely to a depth of at least two miles. Now, if it is true that the earth has been formed by the slow condensation of gaseous matter, we can see no possible reason why any of the gaseous materials should be confined in the interior solidifying portions, and by their attempts to escape cause eructations, or bubbles that could raise any part of the solid mass more than two miles high. In other words, I do not see how there could be any boiling or swelling up sufficient to form land above the surface of the ocean. If then there was no land in this primæval ocean for denudation to act upon, what was it that first disturbed the equilibrium of the crust and so led the way to those stupendous changes that we know have since taken place? But one answer can I think be given to this question, viz., *the origin of life.* Chemists are agreed that carbonate of lime was in solution in this primæval ocean, and when life, or rather life capable of secreting carbonate of lime, appeared it would abstract this substance out of the ocean and deposit it on particular areas, and thus, by disturbing the equilibrium, would prepare the world to be the habitation for those countless myriads of organised beings which now swarm over it.

I will hazard one more supposition. Over this primæval ocean the winds must have swept with great regularity, and currents must have followed in their wake. Now these currents would naturally take two directions, one N.E. and S.W., and the other at right angles to it. If, therefore, we suppose life to have originated at any one point, it would gradually spread in a N.E. and S.W., or N.W. and S.E. direction, and the first calcareous deposits, and consequently the first land, would take these directions also. This would give the direction of other deposits, and although much obliterated by the complications that have since taken place, we can possibly, even now, trace in the directions of our mountain chains some remnant of this primæval arrangement. But this is sheer speculation.

* See also Darwin "On Volcanic Phenomena in South America."—Trans. G. Soc., 2nd Series, V., 601.

Such is an outline of what I propose to call the Herschel–Babbage theory, after the two distinguished philosophers who originated it; it has the advantage over all other theories of the same nature of being capable of being proved or disproved by observations in the field. When firmly established, as I believe it will be, it will throw a new light on geology, for it gives significance to the thickness and composition of every rock, and to its geographical position; it gives significance to every bend and fold in the strata, to every fault and volcanic dyke; and it will also be found to furnish us with a key that will decypher many of the hitherto obscure passages in geological history.

On the Influence of Temperature on Infant Mortality. By Dr. Deck.

(With Illustrations.)

[*Read before the Otago Institute, 19th November*, 1872.]

Although I feel that the subject upon which I have to offer a few remarks is one especially suited to the meetings of a medical society; yet, in the absence of such in this place I have thought it might prove of some interest to the members of this Institute. I was led to collect the few data upon which my remarks are founded on hearing of the extreme heat of the weather during the past summer in England and in North America, and the consequent great increase in infantile mortality with which that hot weather was accompanied. This mortality is thus referred to in the "Lancet" for August, 1872:—

"The effect of the great heat which we have had of late is manifest in the death returns by a large increase in the mortality from diarrhœa. In London the general mortality has risen from 17 to 26 per 1,000 in the last five weeks, the rate last week, 26 per 1,000, being higher than in any previous week this year, a result almost exclusively due to the fatality of diarrhœa, which caused last week 394 deaths. The mortality from this cause was nearly all among children under five years of age, of whom 321 died in their first year. In the eighteen large towns the deaths registered from diarrhœa in the week ending July 6th were 113, during the next fortnight they were successively 226 and 370, and during the last week 604. In Leicester and Leeds the fatality is greater than in London, while in Hull it is equal, but in all the other towns considerably less fatal than in London. The Registrar-General refers in this connection 'to the importance of pure water to children who drink freely in hot weather,' and no doubt that is a most important matter, but it must be remembered that the mortality is to a large extent among infants who are hardly likely to drink freely of water."

The mortality among children from the same cause in New York is thus referred to in the "Lancet" for 10th August, 1872:—

"Heat as intolerable as that which beset the ancient mariner and his crew continues to afflict New York. Not only have cases of sunstroke reached a frightful average, but deaths from nearly every cause still swell abnormally the mortality returns; 1,056 deaths, about double the usual number, were recorded the week before last, while in Philadelphia they amounted to 885, about treble the average. But the infant mortality remains the most appalling feature. Cholera infantum, almost endemic in the Empire City, has assumed something of the proportions of an Egyptian scourge. The heat, with its insanitary sequelæ, operates disastrously on an infant population, which, owing to the premature marriages of its parents, is, as a rule, deficient in stamina and staying power. It is quite usual in New York for a beardless lad of 18

to wed a child of 16, with the inevitable result of begetting a progeny rickety, scrofulous, and (to use the indigenous phrase) hastily run up. Asiatic cholera has already numbered one victim, and New York trembles to think what ravages that pestilence will make when it fairly warms to its work."

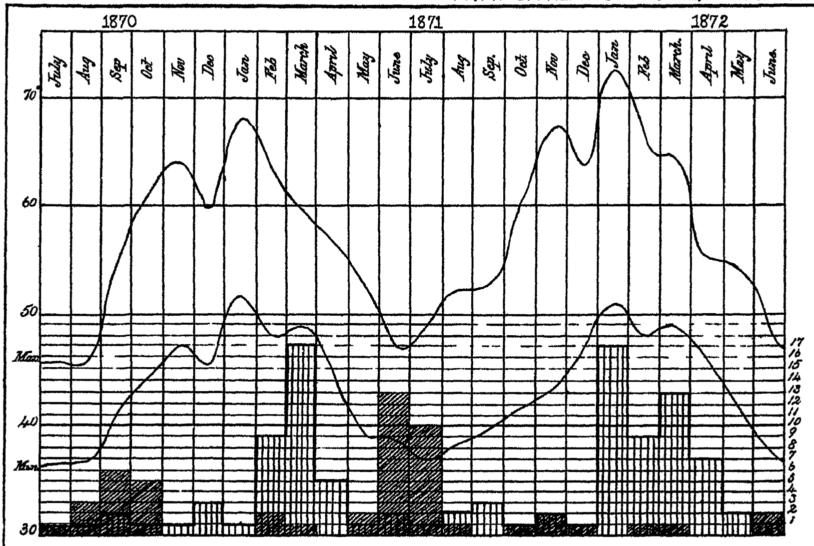
From another medical journal, published in Philadelphia, I extract the following paragraph :—

"The harvest of death. The protracted and unprecedented heat of the first and second weeks of July were accompanied by a mortality in this city of a most startling character. The whole number of deaths for the week ending 6th July was 764, an increase of 350 over the week previous. Of these 274 were from cholera infantum. High as these figures are, they were exceeded by those of the following week, when they reached 852; of this number 497 were children under two years of age, and 383 under one year. Of cholera infantum there were reported 310 cases, and of sunstroke 68."

Recollecting that we had passed through a summer hotter than usual, I determined to compare the mortality among children under two years of age during that season with the mortality during the previous summer, and during other periods of the year.

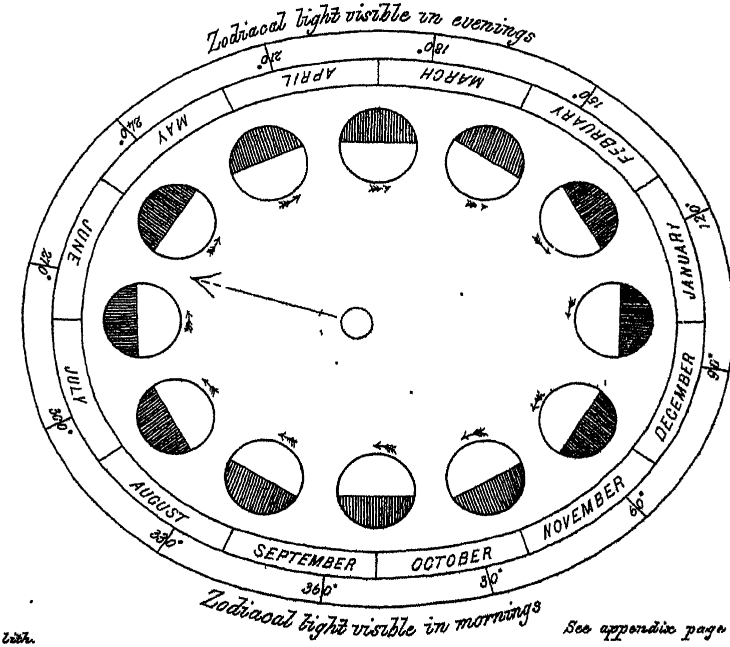
I examined in the Registration Office for the Dunedin district the records of all deaths among children under two years of age during the period of the two years, from 1st July, 1870, to 30th June, 1872. During that time 232 deaths took place. I divided the causes of death into three classes: deaths from affections of the brain, deaths from affections of the respiratory organs, and deaths from intestinal affections. Of the 232 deaths, eight occurred in children that had not reached the age of one week, and the circumstances of their birth had probably more to do with their death than any external cause acting upon them; thirty-three died from affections of the brain, fifty-eight from affections of the respiratory organs, 103 from intestinal disorders, twenty-six deaths were recorded as having occurred from debility or atrophy, two from tubercular disease, without specifying the locus of that disease, one from jaundice, and one from heart-disease. It is to be regretted that the causes of so many deaths are recorded in such an indefinite manner, it takes somewhat from the little value that statistics have, when twenty-six deaths are set down as having occurred from debility or weakness, without specifying the cause of that weakness, or what organs were especially affected.

On examining the periods of the year during which the deaths occurred from those three classes of disease. I found that there was no particular time during which deaths from brain affections were especially prevalent. The summer heat is not intense enough here to produce sunstroke, with ordinary precautions; at least that disease is not of frequent occurrence, and no deaths among infants are attributed to it. The thirty-three deaths that occurred



See appendix page XXVII

Pl. XIV.



J.B. lith.

See appendix page XLIII.

from cerebral affections, such as convulsions, congestion of the brain, and tubercular meningitis, took place, as far as the records of this small number show, with about equal frequency at all periods of the year.

The fifty-eight deaths that took place from affections of the respiratory organs, such as croup, bronchitis, and broncho-pneumonia, occurred with decidedly greater frequency during the winter months. I have laid before you a diagram (Pl. XIII., 2.) which I have drawn up] with the desire to show the variations in the mean, maximum, and minimum temperature for each month during the years above mentioned, and the shaded spaces below show the number of deaths that occurred from diseases of the respiratory organs during those several months. It will be noticed that they occurred principally during, or just after, the depression of the line of temperature in the winter months, during August, September, and October, in 1870, and during June and July in the year 1871.

The 103 deaths that took place from intestinal disorders, such as diarrhœa, dysentery, and cholera infantum, being nearly twice as many as the deaths from respiratory diseases, and three times as numerous as those from brain affections, show that this class of disorders is the one the most serious to infant life. They occurred, as may be seen from Pl. XIII., 1, during the hot summer weather, or they followed it very closely. They occurred principally during February and March in the year 1871, and during January, February, March, and April in the year 1872; the number of cases in each month respectively being indicated by the shaded spaces in the lower part of the diagram.

It will at once be noticed on looking at the curves of temperature in that diagram that the summer of 1871–72 was much hotter than the summer of 1870–71, and the greater rate of infant mortality is visible at once on comparing the shaded spaces referring to those summers. It is to the influence of high temperature in increasing the rate of infant mortality from these affections that I wish especially to draw your attention. The same rule holds good here which has been found to apply in London, New York, and other places, that the higher the rate of the summer temperature the greater the rate of infant mortality that is observed from intestinal affections.

And I would observe that the increased temperature itself, rather than the insanitary sequelæ to which it gives rise (although, no doubt, they are in some measure accountable for the result) seems to be the chief factor at work among the causes that combine together to produce this increased mortality. The case is different when we consider the increased rate of mortality from disease of the respiratory organs during the winter months. Cold weather is often most healthy weather. There may be severe cold, cold weather such as that we experienced during the past winter, when the snow lay upon the ground

for days, and it may be that no time of year is more healthy. I am quite aware that intense cold does produce very dangerous attacks of capillary bronchitis, especially in old people, but I do not think that many bronchitic attacks among infants are thus originated. The epidemics of influenza and bronchitis, to which such attacks are generally due, that occur so frequently during the winter and spring months, seem to be produced by some other agency than the cold itself. Sudden changes of temperature in themselves are scarcely sufficient to bring about such results. There seems to be some other factor at work in these catarrhal disorders that are at times epidemic over such a large area of country. They may be due to some peculiar state of electrical tension in the atmosphere, that is produced at times in cold weather, or rather during sudden changes of temperature; or they may be allied to those zymotic disorders that seem to be dependant on the influence of some germs of which we know little, either as to their mode of production or their character, but I think we may safely come to the conclusion that cold itself is not by any means a chief factor in their production.

But a careful consideration of the circumstances under which intestinal disorders are most prevalent, leads to the conclusion that high temperature, or rather *continued* high temperature, is one of the most important factors at work. It seems to act, if I may use the expression, in a *cumulative* manner. The high mortality takes place only after a certain quantum of heat has been allowed to expend its influence. Suddenly occurring high temperature, which lasts only for a short time, is not followed by these pernicious effects. The high temperature seems to act in the first place as a predisposing, and in the second place as an exciting cause. After the system has been weakened by continued exposure to excessive heat, a further exposure is found to produce these intestinal affections.

It is on this account that in the summer of 1870–71, which was comparatively cool, the chief mortality was at the end of the summer, even with a declining average temperature for the month of March in which it occurred; but in the summer of 1871–72, after a hot November and December, the sudden high increase of temperature in January is accompanied by a sudden and great increase in mortality. The gradual decrease in the mortality after that date is in accordance with the laws that are found to obtain in all epidemics, a certain number of those exposed to any morbid influence, on account of some previous constitutional state are especially susceptible, and are first and chiefly affected, and the rest suffer in a minor degree. Thus the continuation of the high temperature in February and March, 1872, might produce a less result than a lower temperature in February and March, 1871, because those most susceptible to the morbid influence of heat had been already attacked in January of that year.

I have not made any distinction in this diagram between the different kinds of intestinal disorders to which children are susceptible. The manner in which the deaths were registered seemed not to be sufficiently accurate to enable me to do so with any degree of satisfaction. Until some uniform system of nomenclature of disease is adopted by medical men this will be the case. On this account I have preferred to group them all together, but if I could have made a distinction between them we should probably have found that dysenteric diarrhœa was especially prevalent towards the end of the summer, during the prevalence of hot days and cold nights, and that it was that form of intestinal disorder termed cholera infantum which was developed during very hot weather, and was the chief cause of fatality at that time.

These conclusions, which I think may be fairly deduced from the examination which I have made into the causes of the infant mortality during the past two years in the Dunedin district, are more clearly demonstrated by diagrams, showing in an accurate manner, day by day, the connection between high temperature and infant mortality, which have been compiled by Dr. Pemberton Dudley, of Philadelphia. These diagrams show for the summers of the years 1869 and 1870, both the daily maximum temperature from the 15th June to the end of August, and the daily death-rate among infants under two years of age from cholera infantum in the city of Philadelphia, and from them Dr. Dudley arrives at the following conclusions :—

1. That there are marked and sudden fluctuations in the number of deaths from cholera infantum from day to day.

2. That these fluctuations correspond very frequently with fluctuations of temperature, the increase of mortality occurring either on the same day as the increase of temperature, or on the day following.

3. That these fluctuations are more marked about the time that the epidemic is at its height, than at any other period before or afterwards.

4. That there is a gradual rise in the daily mortality from the beginning of the epidemic, and a gradual falling off towards its close, which are not attended with a gradual increase and diminution of temperature.

He adds, "The correspondence between the increase of mortality and the rise of temperature does not entirely disappear at any time during the continuance of the epidemic. It will be perceived, however, that slight changes of temperature are not always attended by any noteworthy increase in the death-rate, and there are times when the temperature on a given day rises to a very high point without being attended by any marked increase in the mortality; but it will be also observed that such days have been preceded by a period of comparatively cool weather. This fact, taken in connection with what was advanced in the fourth conclusion, appears to indicate that a certain amount of hot weather is necessary to create a predisposition to the disease,

and that when the predisposition is once developed, the high temperature of a single day acts as an exciting cause, or at least as an aggravating influence."

He also adds, "Reasoning from these facts alone, we must not conclude that the predisposition induced by hot weather is a mere debility, since if such were the case we should find the greatest mortality towards the end of the hot weather, when this debility is the greatest in degree, and most extensively prevalent; which is not the fact, the records showing a steady decrease in the daily list of deaths, even though the temperature should remain above ninety degrees. Looking at all the facts, is it illogical to infer that cholera infantum requires for its development generally a certain occult condition of the system, which, when acted upon by a certain atmospheric temperature continued for a longer or shorter period, induces a predisposition to the disease; and that children who are not previously in this occult state are not liable to the disease at all, no matter what the temperature and its resulting debility might be?"

These remarks coincide with what I have stated as obtaining in all epidemics. In order to obtain some idea as to what the occult state may be, we ask the following question: At what ages are infants most liable to these disorders? The general idea is that the process of dentition has much to do with these affections, and teething time is looked upon by the public at large with anxiety as the period of infant life most fraught with danger.

The following statement of the ages at which the 103 deaths from intestinal disorders took place, leads to a rather different conclusion:—Out of the 103 deaths, two occurred during the first month, five during the second month, ten during the third month, nine during the fourth month, thirteen during the fifth month, eleven during the sixth month, eleven during the seventh month, fifteen during the eighth month, two during the ninth month, three during the tenth month, eight during the eleventh month, and four during the twelfth month. Ten deaths took place during the second year, and one just over two years old. Seventy-five deaths out of the 103 occurred during the first eight months, and the eighth month was the most prominently fatal.

Dr. Dudley arrives at somewhat similar results from the records of a much greater number. Out of 4,013 deaths that took place in Philadelphia in children under two years of age, during a period of five years, from cholera infantum, he found that 2,073, or more than half, perished before the end of the eighth month, and three-fourths of the number perished before the end of the first year. He found the fifth and the seventh months to be the most prominently fatal of all.

The process of dentition, beginning at the seventh or eighth month, is not completed until the twenty-fourth or thirtieth. It therefore follows that this

disease manifests its power upon infants in whom this process, commonly speaking, has not yet commenced. By the time that the first molar teeth usually make their appearance, the susceptibility to the disease is nearly past. Whatever the process of dentition may have to do in favouring this susceptibility, it must be the development of the teeth in the bony structure of the jaws rather than their eruption through the gums that acts unfavourably.

But there are other considerations that lead to the conclusion that there are agencies at work during these early months of life in producing this susceptibility other than the process of dentition. Cholera infantum seldom attacks in a severe manner children that are *properly nourished*, and at no period of life do causes of mal-assimilation of food, and consequently of mal-nutrition, exist so frequently as during these first eight or twelve months. Suppose a child for whom the maternal supply of food is poor in quality or insufficient in quantity, and that there is a want of suitability in the nourishment that has been given to make up the deficiency, mal-nutrition must be the result. How frequently do such cases occur! How much more likely are they to present themselves during these early months of life than afterwards when the digestive organs are more fitted to act upon a variety of food, Faulty dietetics are most likely to obtain just at those months that we have found to be most fatal to infant life.

Their intimate connection is still further apparent when we consider the organ that this mal-nutrition will act upon with the greatest intensity. Dr. West says, "There is no organ in the body, with the exception of the pregnant womb, which undergoes such rapid development as the brain in early childhood. It doubles its weight during the first two years of life." The brain, then, and the medulla oblongata, the head-centres of nervous life, will be the organs upon which this mal-nutrition will be most injurious. And we can readily understand how injurious the depressing influence of high temperature must be on a system in which these important organs are in a weak, badly nourished, state. And we find in all severe cases of cholera infantum that the brain is as much affected from the onset of the disease as the intestinal canal. That which might have been only a simple diarrhœic attack from some passing irritation, is changed into a severe, perhaps fatal, intestinal disorder through this weakened state of the brain and nervous system. The intimate connection that exists between the two I need not now enlarge upon; the effect upon the intestinal canal of any sudden shock or emotion, which must act through the brain, is well known to everybody. I will only add that the recent experiments of Ranvier throw some light on the nature of this connection. He has shown that œdema of the leg may be produced by section of the vasomotor nerves which supply its vessels, and does not follow ligature of the femoral vein. He has demonstrated that venous congestion

alone is not sufficient to produce œdema, but that the increased exudation from the vessels is rather dependent on want of power in the vasomotor nerves. Supposing this want of nerve-power suddenly to obtain in the vasomotor nerves, regulating the tension and secretory powers of the vessels of the intestinal canal, how soon may this be followed by that which may be equivalent to œdema in the leg, the symptoms that obtain in cholera infantum. I only suggest a consideration of these experiments of Ranvier, as throwing some light on the essence of this disease. An account of these experiments will be found in the "British Medical Journal," 15th June, 1872.

On these accounts I look upon mal-nutrition from faulty dietetics, this mal-nutrition affecting principally the integrity of the brain and nervous system, as the occult predisposing state on which high temperature acts in such a prejudicial manner in producing these intestinal disorders. I will only add that these considerations show how important it is that great attention should be paid to the diet of young infants during hot weather, especially after any continuance of it of long duration. Weaning a child at such a time would be very unwise, and likely to render it susceptible to a severe attack of intestinal disorder, should such occur. All young infants should be protected as much as possible from the effects of high temperature, and an endeavour made during its continuance to invigorate the whole system, and the nervous system in particular, by tepid or cold bathing, and plenty of fresh air during the cool parts of the day.

I would desire also to call attention to the need that exists that some uniform system of nomenclature of disease should be used by all medical men in giving certificates of death. Some uniform system such as that adopted by Dr. William Farr, the Registrar-General of England, should be used by all. At the third conference of the Statistical Congress of the Great Powers of Europe, held in 1857, a nomenclature was agreed upon for adoption in all the States of Europe; it would be well if all the medical men in the colony were supplied with some such system of nosology, that the causes of all deaths might be registered in a methodical and uniform manner. I see by a foot-note in Dr. Aitken's "Science and Practice of Medicine," fourth edition, page 178, that a committee of the Royal College of Physicians of London was then (1864) at work upon a scheme of defining and classifying diseases, which might be an improvement upon that of Dr. Farr's. But I do not know what has been done in the matter. I call attention to this as a matter deserving the attention of all medical men, and I should be glad to learn that something was done in the matter by the authorities at Wellington.

Observations on the Zodiacal Light, tending to show its Connection with the Sun's Motion in Space. By H. Skey.

(With Illustrations.)

[Read before the Otago Institute, 12th March, 1872.]

The remarkable illumination in the heavens, known as the Zodiacal Light, is visible just after sunset, when the air is very clear, during the months of March and April, and again, just before sunrise, during the opposite months of September and October, and follows in a general direction the course of the ecliptic, or, according to Sir John Herschel, that of the sun's equator. Its apparent angular extent from the sun at its base to the vertex of the cone of illumination varies from 40° to 50°, and sometimes even to 90°, with a breadth varying from 10° to 30°. It has been conjectured that it derives its form (that of a lenticularly formed envelope) by its rapid revolution with the sun on its axis, only the upward half of which we see at one time, the other half being below the horizon.

An insuperable objection, however, to this explanation must at once present itself. If we see the upward half of this figure just after sunset, in March, what is there to prevent the other half from being seen during the same month in the mornings, just before sunrise? Why have we to wait till the opposite season?

It follows, therefore, that whatever may be the cause of this illuminated cone, it exists on one side only of the solar orb; and the next step is to account for its visibility at one time of the year only in the evenings, and at the opposite season only in the mornings. Let the accompanying figure (Pl. XIV.) represent the earth's annual motion along the ecliptic, the small arrows indicating the direction of its diurnal rotation; then, as the Zodiacal Light during September is visible in the mornings, it follows that the direction of the cone must point towards some portion of the earth's orbit lying between September and March. For reasons hereafter adduced, let us assume it as constantly extending towards the earth's position early in December (as far as longitude is concerned), and examine the appearance it would present in March, when the earth has arrived at a diametrically opposite part of its orbit.

It will be seen on reference to the diagram that the Zodiacal Light can then only be visible in the evenings, just after sunset, when its extremely delicate illumination ceases to be overpowered by the direct solar light.

In accounting physically for the existence of matter, or of a medium susceptible of illumination, on the one side only of the sun, let us consider the direction of the sun's proper motion in space in connection with some inter-

stellar and resisting medium. From the investigations of astronomers and mathematicians, conducted in a variety of ways, there cannot remain a shadow of a doubt of the reality of solar motion, or as to its direction in space to a point near to Right Ascension, 261° 29′; and to North Polar Declination, 65° 16′, which are the results deduced by Mr. Airy. The point determined by M. Argelander is in R. A., 256° 25′, and N. P. D. 51° 23′, resulting from the examination of twenty-one stars having a proper motion exceeding one minute per annum in arc. The velocity of the sun's motion relatively among the stars, according to M. Otto Struve, is 422,000 miles, or nearly its own semi-diameter per diem.

With a velocity approaching to this, it is not difficult to conceive the effect it must have on the solar atmosphere, if the existence of a resisting medium can be demonstrated. Perhaps the best proof of such a medium is in the observation of comets. They are known to be bodies of extreme tenuity, and Encke's comet has a period of revolution round the sun which is continually diminishing, proving that it is gradually approaching that luminary. The solution proposed by Encke, and the one generally adopted, is that it is retarded by a very rare ethereal medium pervading the regions in which it moves.

In the diagram, the direction of the sun's motion, as projected on the plane of the ecliptic, is shown as Right Ascension 261° 29′, but the North Polar Declination of its motion being 65° 16′, its course will be obliquely upward on the north side of this plane. Here we must consider the difficulty of determining with exactness the direction of the solar motion. Sir John Herschel remarks, "The whole of the reasoning upon which the determination of the solar motion in space rests, is based upon the entire exclusion of any law either derived from observation or assumed in theory, affecting the amount and direction of real motions both of the sun and stars. It supposes the non-recognition in those motions of any general directive cause, such as, for example, a common circulation of all about a common centre."

I might thus illustrate the case. During a calm at sea the smoke from an ocean steamer would give the exact direction of its motion, both when the water was motionless, and also if it was influenced by an ocean current. A ship might be steaming in a northerly direction, and a current might be moving westerly; if both velocities were the same, then the true motion of the vessel would be north-west, as also manifested from the line of smoke; and a person in the ship taking observations on other ships also moving in the same current, but otherwise stationary, would conclude that his ship was moving due north, but in reality the line of smoke would give the resultant of all the compounded motions affecting the vessel. Similarly we may be unable

to determine the sun's true direction in space by the apparent proper motions of the stars, for we may suppose a general movement of the stars in the sun's neighbourhood as drifting in a line parallel to the sun's equator (the most reasonable direction by analogy), then the direction of the Zodiacal Light would be brought nearer still to its observed direction.

From modern researches in solar chemistry we are certain of the existence of the vapours of many metals, and also hydrogen, in the sun's atmosphere. Substances, therefore, of extreme tenuity exist in the vast laboratory of the solar orb. Portions of these substances, under the influence of heat repulsion, must exist at a considerable elevation above the surface, and when subjected to such commotions as have been actually observed (120 miles per second) would be transported to such a distance from the sun as to preclude their revolving around the sun in the same time; moreover, on account of their sudden translation from near the sun's surface to such an increased distance from the centre of diurnal rotation of the sun, some time must elapse before they acquire the additional velocity required. Such masses therefore lag somewhat behind in their daily rotation, and in consequence of the sun's proper motion accumulate in rear thereof. Other portions doubtless might become detached from time to time, forming comets with greatly elongated orbits, having their perihelion passages very close to, and in advance of, the sun's motion until perturbed by the planets.

It becomes interesting to enquire whether the earth ever comes in contact with any portion of this matter, and if so in what part of its orbit?

The illuminated medium known as Zodiacal Light has sometimes been observed reaching our zenith, proving that it extends at times to a distance from the sun fully equal to that of the earth; therefore, if its direction from the sun were truly on the plane of the ecliptic, then the earth must pass very near, if not actually through, its cone, and this at a certain fixed time annually.

In the diagram the cone is drawn on the ecliptic in Right Ascension 261° 29′. If the general direction of this cone extending from the sun were stationary, then the earth would pass very near, if not actually through, it early in December; but it must be borne in mind that the constant attraction of the earth for months too before it reaches this part of its orbit must hasten the time of contact. The November meteors appear to furnish convincing proof of such collision. They were observed in the year 472 (the sky appeared to be on fire over the city of Constantinople, with coruscations of flying meteors); next by the Moravian missionaries in Greenland, and by Humboldt in South America, in which the whole sky was filled with fiery particles, thick as hail, for four hours. Mr. Ellicot also observed these near the West India islands, when the whole heavens appeared as if illuminated

with sky rockets, moving in all directions, excepting from the earth, to which they all seemed inclined more or less, some of them descending perpendicularly over the vessel he was in. They were again seen in the autumn of 1818, when in the language of one of the observers, the surrounding atmosphere seemed enveloped in one expansive ocean of flame. The next exhibition on the grand scale was in November, 1831. This was followed by another in 1832, at the same time. The most splendid display was in November, 1833, when the whole sky is said to have been lit up with these meteors and immense fire balls. One was observed nearly stationary in the zenith for some time, emitting streams of light. Luminous trains marked the path of these meteors, which remained in view for some minutes. This remarkable fact was established, that they all moved in lines which, when traced backwards, converged to the same point in the heavens. The position of this radiant point among the stars was near Leo, which point remained stationary among the stars during the whole exhibition. They were again observed, but on a smaller scale, in Europe and America, in November, 1834, tending, moreover, from the same radiant point. No less than twelve displays have been noticed. They are also found to be more frequent every thirty-three and a quarter years. Accordingly they were anxiously looked for in 1866, at which time they also made their appearance, and their radiant point fixed in reference to the ecliptic in long. 142° 35′, and lat. 10° 27′ N. Now it must be regarded as a very significant fact, that if this point is projected on the plane of the ecliptic it would be very nearly in a line with a tangent to the earth's orbit on the 13th of November. It follows, therefore, that the earth is moving very nearly towards their radiant point. Taking the velocity of the earth in its orbit at twenty miles per second, and the mass and source of the meteors as stationary (excepting, of course, the retrograde velocity imparted to the mass by the earth's attraction, and which would increase the collision), then the compression suddenly exerted on the meteoric matter, and on a portion of the earth's atmosphere, must be enormous, and far quicker than the rate of diffusion which gases are known to possess. Portions of the earth's atmosphere must be arrested, as it were, and its motion partly communicated to unmixed and contracting portions of the meteoric matter, which manifests itself by intense heat. The common experiment of compressing air in a glass syringe, thereby igniting various substances, will give some idea of the heat actually developed. From the suddenness of compression, there would not be time to allow at first the radiation of this heat; consequently ignition must occur, attended, probably, with new chemical combinations, and when that commences, a few seconds suffice to dissipate the smaller meteors; and the larger ones, when they reach the denser atmosphere near the earth, remain for a time suspended (as proved by actual observation);

further contraction then ceases, their heat is radiated, and their gases become diffused in the atmosphere.

That these November meteors differ from the aerolites which have been known to have reached the earth at various times, is clearly proved by none having reached us in a solid state, notwithstanding their extraordinary numbers. The presence of aerolites is also accompanied with loud reports, which are absent in the case of these meteors; surely if they were solid bodies some would have reached the earth and exploded.

Their retrograde motion might be cited as another proof.

It is worthy of note that during the month of December the earth is situated on the sun's equatorial plane, and it appears that it is near its equatorial regions that all the forces emanating from the sun (motion included) are principally exercised.

Notes on the Zodiacal Light. By J. S. WEBB.

[*Read before the Otago Institute, 19th November,* 1872.]

HAVING recently met with an account by Signor Respighi of some spectroscopic observations of the Zodiacal Light, I felt interested to ascertain how far the facts indicated are compatible with the theory broached by Mr. Skey, in the paper he read at our meeting in March last (see preceding article). Looking for other information on the subject to assist the inquiry, I was surprised to find how little was to be obtained. This being so, I have thought that I should render what I have to say more interesting by prefacing it with a general account of this interesting and ill-understood phenomenon.

The account of the Zodiacal Light given by Sir John Herschel is substantially the same as that to be found in Mr. Skey's paper. It has remained unchanged throughout the successive editions of his "Outlines of Astronomy," although some interesting additions to our knowledge of the subject have been made in the meantime. I think Mr. Skey has been somewhat misled by this, as he lays stress on the fact that the Zodiacal Light is, as stated by Herschel, only visible about the vernal and autumnal equinoxes, and for a few weeks before and after those dates, whilst in point of fact it is visible all the year round, or nearly so. This error does not, as it appears to me, invalidate Mr. Skey's theory, but a knowledge of it would probably have led him to alter his diagram (Pl. XIV.) somewhat, and to avoid some of the remarks he has been led to make.

After a search through all the books accessible here which were likely to afford any information, I found the best account of the Zodiacal Light where I least expected it, namely in the introductory notes to Keith Johnston's "School Atlas of Astronomy." These notes are by Mr. J. R. Hind, and I

cannot do better than quote what he says on this subject [Extract read; Keith Johnston's "Atlas of Astronomy," page 5.] I have brought with me the illustration referred to by Mr. Hind which, judging from my own observation and from the accounts of others, conveys a fair representation of the phenomenon.

With regard to the time of the year during which the Zodiacal Light is visible in England, the record of the Rev. T. W. Webb in "Nature," 8th February, 1872 (vol. v., p. 285), of the latest observations there, of which I have seen an acount, corroborates what Mr. Hind says on the subject.

Of the only observation of the Zodiacal Light which I have had the opportunity of making in this hemisphere, I can only speak from memory. It was during the winter months, and the apex of the cone of light, which was on that occasion defined with more than usual clearness, was near one of the brighter stars in the constellation Leo. The sun was at the time far below the horizon, and the distance of the apex from the horizon was fully 40°. A reference to Mr. Skey's diagram will show that if the figure he has given as an approximation to that of the Zodiacal Light is to be taken as an essential detail of his hypothesis, this observation, and indeed all observations during our winter months, decidedly invalidate it. As I have already said, this particular detail does not appear to be essential to the theory, although it renders it desirable that the manner in which it has been expressed should be revised. The general form of the envelope from which we derive the Zodiacal Light may be somewhat as Mr. Skey has supposed, but it is necessary to admit of a very considerable extension in all directions from the sun in and near the plane of his equator, in order to account for its visibility throughout the year.

Various hypotheses as to the constitution of this solar envelope have been put forward. Sir John Herschel speaks of it in his "Outlines of Astronomy," paragraphs 897 and 898. Becquerel, in a recent work, gives the prevalent opinion among French physicists as follows:—"Many explanations of this phenomenon have been offered, the most probable being that which considers it due to a group of bodies which form, as it were, a zone around the sun of solid asteroids, widely separated from one another, but occupying an enormous space, in the midst of which the earth is plunged; aerolites and shooting stars will then be but isolated bodies belonging to this group, which, drawn within the sphere of the earth's activity, fall upon its surface. According to this hypothesis, the Zodiacal Light will be due to reflected solar light, and the absence of polarization which has been observed in it is a result of the light being reflected in all possible planes from the variously presented surfaces of this multitude of bodies."—(Becquerel, *La Lumière ses Causes et ses Effets*, Tome I., p. 7, 1867.) Mr. Skey, as you are aware,

has suggested that the bodies which yield us this mysterious light are wholly gaseous, and form the source of our November meteors.

M. Liais, to whose previous communication Signor Respighi refers in his letter to the *Comptes Rendus de L'Académie des Sciences*, Tome 74, p. 514, 19th Feb., 1872, has long held the opinion that the Solar Corona and the Zodiacal Light are phenomena intimately connected with one another. He endeavours to reconcile the different results they give when examined by the polariscope by suggesting that the bodies which, when seen as the Zodiacal Light, reflect the solar rays from their surfaces, when they approach the sun so closely as to form part of the corona are rendered gaseous and incandescent by the excessive temperature to which they are subjected. (*Comptes Rendus*, Tome 74, p. 263, 22nd Jan., 1872.) His observations serve to connect the Zodiacal Light with that of the Corona; those of Signor Respighi and others demonstrate an intimate likeness between the former and the light of the Aurora, whilst others, still more numerous, have shown independently that at least a part of the Coronal Light is identical in its character with that of the Aurora. I shall not attempt a technical account of these. Plate IX., in Schellen's "Spectrum Analysis," English Translation, 1872, exhibits very clearly the coincidence between certain lines observed in the spectrum of the Corona with those which are peculiar to the Aurora. One of these is the "line in the green," observed by Signor Respighi in the spectrum of the Zodiacal Light. Recent observations of the Aurora have shown that it also yields a faint, almost continuous, spectrum situated similarly to that which Respighi and Liais describe as belonging to the Zodiacal Light. Further, the eclipse observations of December last have shown definitely that besides the lines shown in the plate just referred to, the Corona also yields a continuous spectrum, a part only of which is due to reflected solar light. We must conclude from all this that, though these three phenomena are far from being shown to be identical in character, and although it is not probable that they are so, they have at least one character in common. Though suspected before it is only now that this has been positively demonstrated.

It appears then that the revelations of the spectroscope as to the nature of the Zodiacal Light do not invalidate Mr. Skey's hypothesis that it is yielded by gaseous bodies driven off from the sun during solar cyclones. They nevertheless show that this is not a complete explanation of the phenomenon. The argument for the existence of solid or liquid reflecting bodies in the envelope which the non-polarization of the light affords is in the meantime unanswerable, and is supported by the results of spectroscopic observation. But, so far as our knowledge will carry us, we must assume that attenuated gaseous matter also exists in the region of the Zodiacal Light, and that at least a part of the light we see is caused by electric action upon such matter.

On the Work of the Past Year in Astronomy and Celestial Physics.

By J. S. Webb.

[*Read before the Otago Institute, 17th September*, 1872.]

What I am about to say this evening will not fulfil the promise of the title under which it has been announced, but I hope that it will be of none the less interest on that account. Indeed, any attempt properly to sketch the work of a twelvemonth in such a wide range of research, within the limits of a single address, must of necessity end in a barren and uninstructive catalogue of details. I have only selected for remark a few matters of the greatest interest to all, and in regard to those have confined myself almost wholly to the part of a narrator.

Before entering on the proper subject of this address, I cannot refrain from expressing a regret, which I have no doubt you all share with me, at the fact recently made public that the Astronomer Royal has replied in discouraging terms to the communications addressed to him by the Astronomical Society of Christchurch on the subject of the formation of an efficient Observatory at that city. On the last anniversary of the foundation of the sister Province—on the day of its attaining the mature age of twenty-one years—in one of those bursts of genial enthusiasm so often inspired by the celebration of anniversaries, especially where those celebrations take the form of public dinners, and which do occasionally lead to very useful results, it was determined by some of our public-spirited fellow-colonists in Christchurch that a lasting memorial of the day they were celebrating should be enterprised, and their aspirations (determined by what influences I cannot say) took definite shape in the formation of the society I have alluded to, under whose auspices it is proposed to establish such a memorial in the form of an Astronomical Observatory. This society set about its work in right good earnest, and I think we ought most cordially to wish it success. Within a few years from the present time it is almost certain that an Observatory will be founded in New Zealand. Those of you who take a deep interest in those sciences to which we owe our knowledge of what is beyond the little globe on which we live, will join with me in desiring that this Observatory shall be as near to us as may be. It seems, however, to be very probable that if our friends in Christchurch fail in this creditable enterprise, Auckland will be the chosen spot. In every list that I have seen of the places from which it is intended that British astronomers shall observe the transit of Venus over the sun's disc, in 1874, I notice that Auckland is mentioned. How far this is authoritative I do not know, but it is now nearly two years since it was mooted at a meeting of the Auckland Institute that some steps should be taken to secure

the instruments which would be sent thither for the observation of the transit and so to form the beginnings of an observatory. Now, quite independent of all selfish feelings, I think we shall have cause for regret—a regret which will be shared with us by a great many persons in all parts of the world—if the future observatory of New Zealand is fixed at Auckland rather than in the South Island. In latitudes similar to that of Auckland the world is now girt with a chain of observatories. There used to be in former days an observatory—of what pretensions I do not know—at Hobart Town, but it has, I believe, been dismantled for some years. It is to be desired, therefore, that our New Zealand Observatory should be placed in as high a latitude as possible, and the more so now that the work of an observatory includes so much more than the watching of stars and planets. Only here and in South America can any observatory be planted nearer by any considerable approximation to the South Pole of the earth than that chain of southern observatories to which I have just alluded—a chain which may be considered to be now fairly complete, including as it does those of Paramatta, Melbourne, the Cape of Good Hope, Cordoba, and Santiago. The Christchurch Society has not been wholly discouraged by the unfavourable advices lately received. The nature of these has not, so far as I am aware, been made public, but whatever the objections I trust they will be eventually overcome.

The allusion just made to the chain of observatories which encircles the globe in a line nowhere far distant from the thirty-fifth parallel of southern latitude, reminds me that the establishment of one of these forms part of the work of the past year. It was in October, 1871, that the Argentine Observatory at Cordoba was inaugurated. The staff of observers had been on the spot for some time beforehand, but there had been considerable delay in bringing the instruments into position and working order. In the meantime Professor Gould, the director of the observatory, and his assistants, did not forget that there were astronomers before instruments of modern type were thought of. What they continued to do whilst waiting for their instruments offers an example to all lovers of the science to which they have devoted their lives. After computing the tables necessary for their future work, they set themselves to form a catalogue of all the stars of the southern heavens which are visible to the naked eye. Probably when they began this work they were only endeavouring to familiarize themselves with the field of their future researches, but the patient toil has been rewarded by many interesting discoveries. The variability of a great number of our southern stars has been determined by a comparison of these new observations with those of previous observers. Two of the stars, whose variable character has been established by those patient workers, are remarkable for the short periods during which they pass from maximum to minimum of brightness. One of these stars is in the

constellation Musca. It passes through all its changes in the extraordinarily short period of twenty-one hours and fifteen minutes, and during one-fifth of that time is invisible to the unassisted eye. The other is in the Southern Triangle, and has a period of three and a half days, during part of which time it also is invisible. Professor Gould, in his inaugural address, calls attention to the great field that lies before the southern observer of the fixed stars. The number of stars belonging to the Northern Hemisphere whose positions and magnitude have been catalogued is 330,000, whilst less than a sixth of that number have been defined in the regions south of the equator. Of the latter by far the greater number are stars which are visible in Europe. A circle drawn round the South Pole, with a radius of 60° of latitude, will only include 13,000 known stars, whilst a similar tract of the northern sky includes 164,000. Great as is the difference between the two regions in brilliancy, it is certain that much work has to be done before the catalogues of southern stars reach anything like the perfection of those of the north.

The Cordoba observers have been watching the variabilities of stars. Far vaster changes in celestial objects have been subjects of investigation to other astronomers in this hemisphere. It is now some years since Mr. Abbott, of Hobart Town, pointed out the fact that the star *eta* Argus is no longer actually in the nebula where it was seen by Sir John Herschel. The careful observations of the nebula and neighbouring stars which have been incited by this discovery, have led to the knowledge of extraordinary changes now in progress in this distant object. The Melbourne observers have paid great attention to the subject, and Mr. M'George, in a paper read a few months ago before the Royal Society of Victoria, gave a sketch of the results, illustrated by five drawings of the nebula, as observed at different times. The changes which have occurred since the great Melbourne reflector was first turned towards it have been rapid and most extraordinary. It is much to be regretted that the Royal Society of Victoria is not in a position to publish the more important of the papers read at its meetings, some of which are of world-wide interest. Now that the Melbourne Observatory possesses one of the finest telescopes in the world, we may expect that from year to year the indefatigable and able men who have the charge of it will be in a position to add greatly to our knowledge of the phenomena of the southern heavens. The attention they are paying to this and other nebulæ will no doubt lead to an increase of our knowledge of the physical constitution of these wonderful objects. For instance, when *eta* Argus was first observed to have broken loose from the dense nebula in which it was seen by Herschel, the lines of burning hydrogen were distinctly seen by Mr. Le Sueur in its spectrum. He then offered the conjecture that the star had consumed the nebula. In the latest observations of which I have seen any account no trace of the bright hydrogen lines was found, but the star was

found to be nebulous, the nebulosity being most condensed near it. If, as Mr. Le Sueur conjectured, this star had consumed the nebulous matter which formerly surrounded it, it would appear to have found a fresh envelope.

Mankind for ages believed that the celestial orbs ruled the destinies of men in some occult but very direct manner. Science is gradually restoring to us some phases of this faith. The influence which the physical circumstances that surround him have upon the character and actions of the individual man, has been made clear by the comparison and classification of innumerable observations. The statistics of human life, of human action, and human manners, have been brought into conjunction with those of the physical conditions to which our race is subjected, and wonderful and most convincing coincidences have been revealed; and at the same time we have been learning how intimate is the tie which binds together all things that exist in the universe. It is no new thing to acknowledge the rule which the sun has over the physical conditions which prevail upon our planet; but it is only of late years that we have been taught to appreciate at their full intent the influences which are brought to bear upon the sun from without—influences which dictate the character of his dealings with the subordinate members of this system, of which he is the ruling centre. The time has gone by when the sun was accepted as a self-sufficient source of light, and heat, and power. Irreverent investigators inquire into his pedigree, speculate upon the sources of his annual income of force, calculate the probable length of his present existence, and dogmatize on the nature of the "future state" that is provided for him. We have long since satisfied ourselves that there is no certainty about the sun; we suspect him of being influenced by the fair face of any planet that happens to be in aphelion, accuse him of consuming comets behind the scenes, and of devouring myriads of asteroids to keep himself and his subject planets warm. And so we have come to recognize the fact that, as the moral condition of a nation depends upon its harvests, so do these harvests depend upon the physical condition of the sun's surface, whilst this, in its turn, depends upon other things of which we have as yet but little knowledge, but of which we know enough to certify us that they again are not independent phenomena, but are moulded and made what we find them by the flux and reflux of cosmical forces whose origin is far beyond our ken, and of whose mode of action we have but a faint glimmer of knowledge.

Such reflections as these are inevitably excited in the minds of those who address themselves to the study of the current labours and speculations of their fellow men in the departments of science with which we are occupied to-night. The past winter in the Northern Hemisphere, as with ourselves, was remarkable for the occasional intensity of its cold, and general severity of its weather. In November and December the cold was very severe, then

followed a period of eight or ten weeks during which the temperature was above the mean, followed by another period of unusual cold. A careful examination of such records as are available convinces us at once that such a circumstance is no fortuitous accident. There is a weather cycle, not yet perhaps so clearly defined, but certainly as well ascertained as any of those cycles of celestial movements which depend on the unvarying law of gravitation. The temperature of the earth's surface varies from year to year, and shows a maximum every eleven years, or rather in periods of a little more than eleven years. Just before the maximum, and just after it, come the periods of lowest temperature. Very lately, Professor Smyth in Edinburgh, Mr. Stone at the Cape of Good Hope, and Mr. Abbe at Cincinnati, each working upon different materials, have pointed out the close coincidence between the curve of varying terrestrial temperature and that of the sun-spot periods; this is the first generalization. Observations of the sun's surface have not yet extended over a period sufficiently long to admit of a comparison of the phenomena presented with that more extended cycle of about forty-one years which M. Renou long ago deduced from his investigation of the records of great winters. The connection between terrestrial variations of climate and the sun-spot period being established, we at once desire to push our investigation a step further. If the character of our winters depends on the condition of the sun's surface what is it that rules the latter phenomenon? Is the cause within the sun itself, or may we look for it without? Analogy and the cyclic character of the variations lead us to prefer the latter solution. The extraordinary character of the weather of the last and preceding years, the recent extension of our means of examining the surface of the sun, the unusual magnificence of certain auroral displays which have occurred during the period I have under review to-night, have combined to direct the attention of physicists to the inter-connection of various cosmical and terrestrial phenomena. The result has been that every research leads to surer convictions of the inter-dependence of natural phenomena; whilst the further we push our investigations the more we feel that the ultimate cause of those phenomena eludes our grasp.

No natural phenomenon of modern times has evoked at the moment of its occurrence a greater mass of scientific record and speculation than the aurora which, on the night between the 4th and 5th of February last, astonished Europe, and fired the skies over one-half the globe. This aurora was visible in North America and the West Indies, over the whole breadth of Europe, in Western Asia, at the Mauritius, and in Western Australia. There can be very little doubt that, had daylight not interfered to prevent it, the magnificent spectacle which it presented would have been seen from every point on the surface of the globe.

This splendid aurora was coincident with a period of equally notable agitation of the surface of the sun. Signor Tacchini, the Director of the Observatory at Palermo, who devotes himself with great ardour to the spectroscopic observation of the sun, thus describes the condition of things which he found prevailing when the sun rose on the morning of the 5th:—"All the surface of the sun was in abnormal circumstances; the entire rim was covered with splendid flames; towards the North Pole these rose to the height of 20″ (equal to about 9,000 miles), over an arc of 36° to the right and to the left, corresponding to a region of (incandescent) magnesium which on the western border extended to the Equator. In this region, at 50° from the pole, a magnificent protuberance was observed which rose to a height of 2′ 40″ (more than 70,000 miles), and from this point through an arc of 40° the rim presented numerous brilliant flames, and the atmosphere was completely encumbered with luminous threads and shining points up to a height of 2′ (55,000 miles). The chromosphere was throughout more elevated than usual." Along with this agitation of the surface of the sun was to be noted the striking brilliance of the zodiacal light, which some physicists are now maintaining to be in fact a solar aurora. Intimately connected with the auroral display was the appearance of a group of meteors, the radial point of which was in an unusual position. As usual on such occasions a magnetic storm prevailed, and the various telegraph lines including the Atlantic cable were taken possession of by induced currents, which for a considerable period rendered it impossible to work them.

The unusual climatic conditions, and the exceptional prevalence and intensity of auroras (that of 4th February was only the most conspicuous of an extensive series), have filled the transactions of scientific societies and the pages of periodicals devoted to science with statistics, arguments, and theories, all having for their object the elucidation of the cosmical origin of those terrestrial phenomena. I purposed to have given a general account of these to-night, but time will not permit. The intimate connection between both these classes of phenomena and the condition of the surface of the sun is, of course, a fundamental feature with all of them. Signor Tacchini gives it as his opinion that "our polar auroras are nothing else, at least in the majority of cases, than phenomena of electric induction due to the immense auroras produced on the sun." In one form or another this is admitted by almost all theorists on the subject. One theorist has with much ingenuity attempted to connect these phenomena with one another, not as cause and effect, but as both resulting from a common cause. M. Silbermann, after a life-long study of atmospheric currents, forms of clouds, shooting-stars, auroras, and solar phenomena, has reached the conclusion that the innumerable streams of meteors which the earth is continually passing through, are the efficient causes

of all these phenomena. In regard to the auroras of last February he has pointed out that a meteor-stream made its presence known by shooting-stars at the time of the auroral display of the 4th. In the case of auroras in January he traces a stream of meteors from the neighbourhood of Jupiter, where but a short time before phenomena of a very singular character were observed, which he claims to have been the effect of similar auroral displays in the Jovian atmosphere. Jupiter's third satellite passed between us and the disc of the planet in December last. Those who were observing it saw with surprise that instead of appearing bright on the grey background of the planet's atmosphere, it appeared black in contrast with a light of unusual brilliance and of a rosy tint, which seemed to be produced in the atmosphere of the planet, and which some observers conjectured to be a Jovian aurora. A few days afterwards, early in January, 1872, some fine auroras brightened the atmosphere of our own planet, and very shortly afterwards an extraordinary number of protuberances and hydrogen jets made their appearance on the sun. The stream of meteors—to the action of which M. Silbermann attributes the occurrence of all these phenomena—continued to pass the earth for some weeks afterwards, making its presence known by shooting stars radiating from a particular point in the heavens, near the place of Jupiter, and by the auroras of 4th February and 22nd and 23rd of the same month, which accompanied these apparitions.

The central point in the astronomical work of the past year is undoubtedly the observation of the eclipse of December last. The secrets of the chromosphere having been so successfully unravelled, the attention of astronomers was, during the last eclipse, devoted in a great measure to the solution of another grand solar problem—the constitution of the Corona. This question may be said to have been definitely set at rest by the observations then taken. The most successful observations were those of M. Janssen, and I very much regret that his detailed account of them has not yet reached this distant corner of the world, not having been presented to his associates of the French Academy of Sciences up to the end of June. On this account, and because this address is otherwise too long, I propose to remit my remarks on this eclipse to some future occasion. Here I will merely say that the observations of December last definitely prove that the coronal light, which is seen during a total eclipse, is not a simple phenomenon. It is partly derived from reflection of solar light by the particles of a true solar atmosphere, and partly from hydrogen, and probably some other substances, which are at a sufficiently high temperature to be self-luminous.

Setting aside the eclipse observations for the present, the most interesting of the work that has been performed by astronomers during the past year is that which relates to the chromosphere of the sun. Since the method of

spectroscopic observation, by which it is possible to examine this curious region of the sun in broad daylight, was made known, it has been the subject of most ardent investigation in all parts of the world. The Directors of some of the Italian Observatories have, however, taken a decided lead in this interesting field of research. Signor Tacchini, to whom I have already alluded, and Father Secchi, the Director of the Roman Observatory, have been making simultaneous daily observations and drawings of the borders of the sun. Their labours, coupled with those of Lockyer, Huggins, and others in England, have already secured for us a knowledge of what is going on in this particular region of the sun, which may almost be looked upon as complete so far as the phenomena themselves are concerned, although we are yet very far from having anything which we can fairly dignify with the name of knowledge of the proximate causes of what we observe. Father Secchi has contributed to the Proceedings of the French Academy of Sciences what I may call a descriptive catalogue of the phenomena which are to be observed in the chromosphere and protuberances. . . . [Mr. Webb proceeded to give a description of the various appearances presented from time to time by the chromosphere and the "red prominences" which arise from it, which would scarcely be intelligible without the drawings by which it was illustrated. These drawings were coloured copies on a large scale of those which illustrate Father Secchi's paper in the "Comptes Rendus," T. LXXIII., pp. 826, *et seq.*, 2nd October, 1871. After an allusion to the forms of some of these detached masses of flame which have the character of clouds, as "evidently due to the action of fierce atmospheric currents," he proceeded as follows :—] Father Secchi considers that he has established, by a twelvemonth of patient observation, the existence of such currents on the sun having a general set from the equator to the poles, varied by local circumstances in the neighbourhood of important sun-spots. This result has been contested with some spirit, especially by M. Faye, the President (last year) of the French Academy. Those astronomers who are most familiar with the chromosphere appear, however, to accept Father Secchi's theory, satisfied that the observed phenomena coincide with it, and not disposed to make too much of theoretical difficulties. The latter are, indeed, found to be very great when we attempt to explain to ourselves how a circulation can exist on the surface of the sun having any analogy to the trade winds which prevail in certain regions of the earth—or rather to those upper reverse currents which accompany these phenomena. We can account for our own winds by the action of the sun upon our atmosphere, but we are entirely at a loss when we come to inquire how an atmospheric circulation similar to that which the earth enjoys should be engendered on the sun itself. That such currents do exist appears to be established, and when we find a satisfactory theory by which to account for the extraordinary peculiarities

of the solar rotation, which is far more rapid at the equator than near the poles, we shall probably also find the clue to the problem of solar trade winds.

I fear I have exhausted your patience. I have certainly exhausted the time at my disposal either for the preparation or delivery of this address. My subject, however, remains quite inexhaustible; and, with the eclipse of December last, at least one-half of my notes must be remitted as material for a future address.

HONORARY MEMBERS

OF THE

NEW ZEALAND INSTITUTE.

1870.

Agassiz, Louis
Drury, Captain Byron, R.N.
Finsch, Otto, Ph.D. of Bremen
Flower, W.H., F.R.S., F.R.C.S.
Hochstetter, Dr. Ferdinand von
Hooker, Joseph D., C.B., M.D., F.R.S.
Mueller, Ferdinand von, C.M.G., M.D., F.R.S.
Owen, Richard, D.C.L., F.R.S.
Richards, Rr.-Adml. G. H., C.B., F.R.S.

1871.

Darwin, Charles, M.A., F.R.S.
Gray, J.E., Ph.D., F.R.S.
Lindsay, W. Lauder, M.D., F.R.S.E.

1872.

Grey, Sir George, K.C.B.
Huxley, Thomas, H., LL.D., F.R.S.
Stokes, Vice-Admiral J. L.

1873.

Bowen, Sir George Ferguson, G.C.M.G.

ORDINARY MEMBERS.

1872.

WELLINGTON PHILOSOPHICAL SOCIETY.

Allan, A. S., Wellington
Allan, J. A., ditto
Allan, J. G., ditto
Allen, F., ditto
Allen, W., ditto
Andrew, Rev. J. C., Wairarapa
Baker, Arthur, Wellington
Bannatyne, W. M., ditto
Barleyman, John, Blenheim
Barron, C. C. N., Wellington
Batkin, C. T., ditto
Beetham, W., Hutt
Bell, C. N., C.E., Wellington
Best, W., ditto
Betts, F. M., Wanganui
Bidwell, C. R., Wairarapa
Blackett, J., C.E., Wellington
Blundell, H., senior, ditto
Blundell, Henry, Treasury, ditto
Bothamley, A. T., ditto
Boughton, Adino, ditto
Bowden, T., B.A., ditto
Bradshaw, J. B., M.H.R., Dunedin
Braithwaite, A., Hutt
Brandon, A. de B., junior, Wellington
Brogden, James, ditto
Buchanan, John, Wellington
Buchanan, T., ditto
Bull, James, Rangitikei
Buller, J. W., Wanganui
Buller, W. L., D. Sc., F.L.S., F.G.S., ditto
Carruthers, John, C.E., Wellington
Clarkson, J., ditto
Colenso, W., F.L.S., Napier
Collins, R., Wairarapa
Cooper, W., Makara
Cowie, G., Wellington
Crawford, J. C., F.G.S., ditto
Davis, James, ditto
Dobson, A., C.E., Nelson
Dransfield, J., Wellington
Duigan, J., Wanganui
Edwards, Major, Wanganui
Edwin, Commander, R.N., Wellington
Featherston, I. E., London
Ferard, B. A., ditto
Floyd, W H., Auckland
France, Charles, M.R.C.S.E., Wellington
Fraser, The Hon. Capt., F.R.G.S., Dunedin

George, J. R., Wellington
Gillon, E. T., ditto
Gore, R. B., ditto
Gould, George, Christchurch
Grace, The Hon. M. S., M.D., Wellington
Graham, C. C., ditto
Gray, William, Lyttelton
Green, H., Wellington
Hamilton, W. S., ditto
Harrison, C. J., ditto
Hart, the Hon. Robert, ditto
Hector, James, M.D., F.R.S., ditto
Holdsworth, J. G., ditto
Holmes, R. L., F.M.S., Fiji
Hood, T. Cockburn, F.G.S., Wellington
Hulke, Charles, Wanganui
Hurley, J., Wellington
Hutton, Capt. F. W., F.G.S., ditto
Inwood, D., ditto
Jackson, H., F.R.G.S., Hutt
Johnson, The Hon. G. Randal, Napier
Johnston, The Hon. John, Wellington
Kebbell, J., Wellington
Knight, Charles, F.R.C.S.E., ditto
Knowles, J., ditto
Knox, F. J., L.R.C.S.E., Johnsonville
Krull, F. A., Wellington
Levin, W. H., ditto
Levy, Lipman, ditto
Locke, Samuel, Napier
Logan, H. F., Wellington
Lomax, H. A., Wanganui
Ludlam, A., Hutt
Luxford, W., Wellington
Lyon, W., F.G.S., ditto
McKenzie, Thomas, ditto
McTavish, A., ditto
Magniac, H., ditto
Mantell, The Hon. W. B. D., F.G.S., ditto
Marchant, J. W. A., ditto
Marchant, N., ditto
Martin, J., ditto
Mason, Thomas, Hutt
Mills, E. W., Wellington
Monteith, J., ditto
Moore, George, Wellington
Nairn, C. J., Hawke Bay
Nancarrow, J., Wellington
Nelson, F., Napier
Nicholas, H. E., Wellington
Nichol, Charles, ditto
Ollivier, F. M., ditto
Park, George, ditto
Parsons, W. F., ditto
Pearce, E., M.H.R., ditto
Pharazyn, C., Wairarapa
Pharazyn, The Hon. C. J., Wellington
Pharazyn, R., F.R.G.S., Wanganui
Pharazyn, W., B.A., LL.B., Wellington
Plimmer, Isaac, ditto
Potts, T. H., F.L.S., Lyttelton
Powles, C. P., Wellington
Prendergast, J., ditto
Quick, W. H., ditto
Reid, W. S., Wellington
Rhodes, The Hon. W. B., ditto
Richardson, C. S., ditto
Richmond, The Hon. J. C., Nelson
Samuels, W. R. G., M.R.C.S.E., Wanganui
Seymour, His Honour A. P., Superintendent of Marlborough
Skey, W., Wellington
Smith, Benjamin, ditto
Smith, Charles, Wanganui
Stewart, J. T., Assoc. Inst., C.E., Manawatu
Taylor, The Rev. R., F.G.S., Wanganui
Toxward, C. J., Wellington
Travers, H. H., ditto
Travers, W. T. L., F.L.S., ditto
Tuckey, H. E., B.A., ditto
Warburton, G., ditto
Waterhouse, The Hon. G.M., F.R.G.S., ditto
Webb, J. S., Dunedin
West, The Rev. W. H., Wellington
Wilcox, H., ditto
Woon, R. W., Wanganui
Young, T. W., Wellington

AUCKLAND INSTITUTE.

Aickin, G., Auckland
Aitken, W., ditto
Alexander, C., ditto
Allom, A. J., Shortland
Atkin, W., Tamaki
Atkin, William, Auckland

Baber, J., C.E., Auckland
Ball, T., Mongonui
Barstow, R. C., Bay of Islands
Beere, D. M., Shortland
Beetham, A., Auckland
Brookfield, F. M. P., ditto
Bruce, Rev. D., ditto
Buchanan, James, ditto
Buchanan, Jno., ditto
Buckland, J. S., ditto
Buckland, W. T., ditto
Buller, Rev. J., Grahamstown
Campbell, H., Auckland
Campbell, J. L., M.D., ditto
Chamberlin, The Hon. H., Parnell
Chapman, G. T., Auckland
Cheeseman, T. F., Remuera
Clark, J. M., Auckland
Clarke, H. T., Tauranga
Cochrane, S, Auckland
Codrington, The Rev. R. H., Norfolk Island
Cowie, The Right Rev. W. G., D.D., Bishop of Auckland
Cruickshank, D. B., Auckland
Daldy, W. C., ditto
Davy, G. B., Shortland
Dawson, F. W. H., M.D., Auckland
Dyson, R. W., ditto
Earl, W., Remuera
Farmer, The Hon. J., ditto
Firth, J. C., Auckland
Fish, T., ditto
Floyd, W. H., ditto
Ford, S. H., M.D., Russell
Fox, A., M.R.C.P., Shortland
Fraser, G., Auckland
Fraser, J. M., ditto
George, J., Auckland
Gibbons, E., Onehunga
Gillies, His Honour T. B., Superintendent of Auckland
Gittos, B., Auckland
Goldsboro', C. F., M.D., ditto
Gorrie, W., ditto
Graham, W. K., London
Hall, J. W., Grahamstown
Hankey, E. A., London
Hannaford, M., Remuera
Harding, S., Auckland
Haultain, The Hon. Colonel T. M., ditto
Hay, D. ditto
Hay, W. M., Papakura
Heale, T., Auckland
Heaphy, C., V.C., Major A.R.V.
Heather, A., Auckland
Henderson, J., ditto
Henderson, T., junior, ditto
Higginson, H. P., ditto
Hill, W., junior, ditto
Hobbs, R., ditto
Humphreys, W., ditto
Hunt, R. R., Ngaruawahia
Hunt, W. A., Remuera
Hutton, Captain F. W., F.G.S., Wellington
Jackson, S., Auckland
Jones, O., ditto
Jones, S., ditto
Jordan, R. C., Tauranga
Kenny, N., Ngaruawahia
Kidd, R., LL.D., Auckland
Kinder, Rev. J., M.A., ditto
Kinloch, E., Otahuhu
Kirk, T., F.L.S., Auckland
Kirton, G., Napier
Kissling, G. S., Parnell
Lackland, J., Auckland
Lamb, J., Riverhead
Larkworthy, F., London
Leaf, C. J., F.L.S., F.G.S., London
Lee, W., M.R.C.S.E., Auckland
Lodder, W., Parnell
Lusk, H. H., Auckland
Lyell, J. L., Epsom
MacCormick, J. C., Auckland
Macdonald, D. E., ditto
Macfarland, R. J., C.E., Grahamstown
Macfarlane, J. S., ditto
Macffarlane, T., Auckland
Mackay, R., ditto
MacKechnie, E. A., ditto
MacKellar, H. S., ditto
Mackelvie, J. T., ditto
MacLean, B., Tamaki
MacLean, The Hon. D., Napier
MacLean, E., Howick
MacRae, F., Auckland
Mair, Captain G., Tauranga
Mair, H. A., Parnell
Mair, R., Whangarei
Mair, Major W. G., Alexandra
Manning, F. E., Hokianga
Mason, J., Parnell
Maunsell, The Ven. Archdeacon, Parnell
Meinertzhagen, F. H., Napier

Mitford, G. A., Parnell
Monro, H. A. H., Auckland
Morrin, T., ditto
Morrin, W., ditto
Morton, H. B., ditto
Murdoch, D. L., Epsom
Nation, Lt.-Col., Parnell
Nicholson. J. R., M.D., Auckland
O'Neill, C., ditto
Ormond, The Hon. J. D., Napier
O'Rorke, The Hon. G. M., Onehunga
Owen, G. B., Epsom
Palmer, W. J., Auckland
Peacock, T., ditto
Pearce, R. J., ditto
Perkins, E., ditto
Phillips, P. A., ditto
Phillips, C., ditto
Phillipson, T., ditto
Pollen, The Hon. D., M.D., Te Whau
Preece, J. W., Auckland
Purchas, Rev. A.G., M.R.C.S.E., Onehunga
Rapson, S., Auckland
Roberton, J., ditto
Roberts, W. C., Hokitika
Russell, T., Auckland
Scott, W., Paterangi
Sheath, A., Auckland
Sheehan, J., M.H.R., ditto
Sheppard, A. M., Whangape
Shera, J. M., Auckland
Sinclair, A., ditto
Smart, J., ditto
Smith, S. P., ditto
Spencer, W. D., M.D., Napier
Stewart, J., C.E., Auckland
Stewart, T. M., Melbourne
Stone, C. J., Auckland
Taylor, C. J., Tamaki
Thorne, G., jun., Auckland
Tinne, T. F. S., ditto
Tothill, C., ditto
Upton, J. H., ditto
Vilcoq, A., Russell
Vogel, The Hon. J., Wellington
Von der Heyde, G., Auckland
Wardrop, A., ditto
Ware, W., ditto
Wark, J. N., Sydney, New South Wales
Wayland, J. M., Onehunga
Waymouth, J., Auckland
Wayte, E., ditto
Webster, J., Hokianga
Weetman, S., Auckland
Weston, T. S., ditto
Whitaker, F., ditto
White, T. L., ditto
Will, W., ditto
Williams, H., Bay of Islands
Williams, The Ven. Archdeacon W. L., Poverty Bay
Williamson, The Hon. Jas., Auckland
Wilson, Capt. J., Cambridge
Wilson, J. T., Whangarei
Wilson, W. C., Auckland
Wright, F. W., L.M.B. Toronto, ditto
Wrigley, J., Auckland

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Anderson, John
Armstrong, A. F.
Aynsley, H. P. M.
Back, Alexander
Barker, A. C.
Bealey, S.
Beaufort, H. W.
Blakiston, A. F. N.
Blakiston, C. R.
Bowen, C. C., F.R.G.S.
Bray, W. B.
Buckley, The Hon. George
Carruthers, W. D.
Clogstown, Captain
Condell, T. D.
Coster, J. L.
Coward, F. W. S., L.S.A.
Cowlishaw, W. P.
Cox, Alfred
Craig, David
Davis, Richard
Dixon, M.
Duncan, Andrew
Duncan, Thos. S.
Enys, J. D., F.G.S.
Fereday, R. W.
Frazer, Rev. C.
Gould, George
Gresson, His Honour Mr. Justice, B.A.
Griffiths, E. G.

Haast, Julius, Ph.D., F.R.S.
Hall, George
Hall, The Hon. John
Hall, T. W.
Hanmer, Philip
Harper, The Right Rev. H. J. C., D.D., Bishop of Christchurch and Primate
Harper, Leonard
Hart, George
Hennah, H. H.
Hewlings, S.
Hill, J. R.
Inglis, John
Jameson, Andrew
Jollie, Edward
Lane, W. H.
Mainwaring, R.
Marshman, J.
Maskell, W. M.
Mills, W.
Montgomery, W.
Mountfort, B. W.
Palmer, Joseph
Parker, H. B.
Potts, T. H., F.L.S.
Powell, Ll., M.D.
Prins, H. H.
Rhodes, R. H.
Robison, W. S.
Rolleston, His Honour W., B.A., Superintendent of Canterbury
Ross, T. V.
Sealey, E. P.
Smith, J. M.
Stack, Rev. W.
Strouts, F.
Tancred, H. J.
Tancred, T. S.
Thornton, G., C.E.
Turnbull, J. S., M.D.
Wakefield, C. M.
Walker, L.
Webb, H. R.
Wilkin, Robert
Williams, J. S.
Wilson, The Venerable Archdeacon
Wilson, William
Wright, F. E.
Wright, T. G.

OTAGO INSTITUTE.

Abel, H. J., Lawrence
Abram, G. P., M.A.
Adams, C. W.
Arthur, W.
Baker, J. H., Invercargill
Barr, G. M., C.E.
Barnet, A. A.
Barton, Geo. E.
Bathgate, John, M.H.R.
Bathgate, Alexander
Bell, George
Beverley, Arthur
Black, Prof., M.A., D.Sc.
Blair, W. N., C.E.
Borrows, Dr., R.N.
Brent, Daniel, M.A.
Buchanan, Hon. Dr.
Burn, Mrs.
Calcutt, Thomas
Campbell. G. H.
Cargill, E. B.
Cargill, John
Chapman, His Honour Mr. Justice
Chapman, Robert
Chapman, F. R.
Deck, Dr.
Eccles, Alfred, F.R.C.S.
Finch, Jas.
Fleming A., M.D., Oamaru
Fraser, William, Earnscleugh
Fulton, F. C.
Fulton, James
Gardiner, R. S.
George, Thomas
Gillies, Robert
Glasgow, W. T.
Granger, Rev. E. H., M.A.
Haggitt, B. C.
Hardy, Jno., Oamaru
Hawthorne, Stuart, M.A.
Hepburn, William
Hislop, John
Hocken, T. M., M.R.C.S.E.
Hodgkins, W. M.
Holmes, Allan
Howorth, Henry
Humphreys, E. W.
Jeffcoat, F.
Jennings, E.

Lindsay, W. Lauder, F.R.S.E., F.L.S., Perth, N.B. (Hon.)
Logan, John
Lubecki, A. D.
Macassey, James
Maclean, H. J.
McGregor, John
McKerrow, James
McKerras, J. T.
Martin, R. B.
Martin, W., Green Island
Mason, William
May, J. T.
May, Mrs. J. T.
Murison, W. D.
Muston, C.
Neill, Percy
Nevill, The Right Rev. S. T., D.D., Bishop of Dunedin
Oliver, Richard
Oliver, Thomas
Penny, Rev. E. G., M.A.
Percival, W. J.
Prentice, N.
Purdie, A. C.
Quick, E. E. C.
Rattray, James
Reynolds, W. H., M.H.R.
Ritchie, J. McF.
Roberts, F.
Ross, A. H.
Russell, G. G.
Sale, Professor, M.A.
Shand, Professor, M.A.
Sievwright, Basil
Simpson, D. L.
Skey, H.
Smith, James
Stables, John
Stewart, Alexander
Stewart, Alexander, M.D., Lawrence
Stewart, W. D.
Stout, Robert
Street, C. H.
Strode, A. R. C.
Stuart, The Rev. Dr.
Tewsley, Henry
Thomson, J. T., F.R.G.S.
Thomson, Peter
Thomson, Geo. M.
Thoneman, L.
Tolmie, W. A.
Turnbull, George
Turton, G. K.
Walcot, James A.
Walter, H. J.
Watson, J. T.
Watt, I. N.
Webb, J. S.
Weldon, T. K.
Wilkie, J., jun.
Willis, Alexander
Wilson, James
Yates, Dr. W. A.
Young, George
Young, W. A., Palmerston

NELSON ASSOCIATION FOR THE PROMOTION OF SCIENCE AND INDUSTRY.

Atkinson, A. S.
Batchelor, T. C.
Blundell, F.
Bonnington, George
Boor, Leonard, M.R.C.S.
Broad, Charles
Brown, Alexander
Browne, C. Hunter
Carter, Thomas, Wairau
Catley, J. T.
Collins, A. S., M.H.R.
Cotterell, C. E., M.R.C.S.
Curtis, H. E.
Davis, William
Dick, S. J.
Dobson, A. D., C.E., Westport
Elliott, C.
Farrelle, W. K., L.R.C.S.E.
Fell, C. Y.
Grant, A.
Greenwood, J. D., M.D., Motueka
Giles, Joseph, M.D., Westport
Huddleston, F.
Harley, J.
Harley, William
Harvey, O. W.
Hodgson, W. C.
Holloway, J.
Irvine, F. W., M.D.
Ladley, Walter
Lee, Robert
Levastam, H. A.
Lightband, G. W.
Lowe, J. T.

Lucas, R.
Mackay, A.
Mackay, Joseph
Mackay, Thomas, C.E.
Monro, Sir David, M.D.
Moutray, J. C.
Packer, J. A.
Renwick, The Hon. T.
Richardson, R., M.H.R.
Richmond, The Hon. J. C.
Rough, D.
Sadd, J. B.
Sclanders, A.
Sclanders, James
Sealy, W. B., M.D.
Shephard, J.
Simmons, F. C., M.A.Oxon
Smith, Jno.
Squires, W. W., M.D.
Stafford, The Hon. E. W.
Suter, The Right Rev. A. B., D.D., Bishop of Nelson
Tatton, J. W.
Thorpe, The Rev. R J., M.A.
Tomlinson, W.
Vickerman, F. L., M.D.
Wakefield, Felix, F.L.S.
Webb, Joseph
Wells, William
Williams, George, M.D.
Wright, T. M.